Rockwell International
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SUPPORTING DOCUMENT

GO NO.	S/A NO.	PAGE 1 OF	TOTAL PAGES	REV LTR/CHG NO SEE SUMMARY OF CHG	NUMBER
09465	30012	59	59	NC	N065SRR205006

PROGRAM TITLE

Decommissioning De Soto

DOCUMENT TITLE

Radiation Survey for Phase III Release for Unrestricted Use of ESG Headquarters, Building 001

DOCUMENT TYPE

Safety Review Report

KEY NOUNS

Decontamination, Decommissioning

ORIGINAL ISSUE DATE

REL. DATE 1-17-84

APPROVALS M. E. Remley — DATE 14 Nov 83

PREPARED BY/DATE R. J. Tuttle 11/14/83 — DEPT 779 — MAIL ADDR NB13

IR&D PROGRAM? YES ☐ NO ☑
IF YES, ENTER TPA NO.

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ABSTRACT

Following cleanup of radioactivity exceeding specified limits, a radiation survey was performed in the parts of Building 001 identified as Regions IIA and III. The results of this survey show that these regions meet the criteria established by NRC for release for unrestricted use.

The radiation survey for Phase I (Regions IA and IB) has been described in a previous report (N001SRR130011). The radiation survey for Phase II (Region IIB) has also been described in a previous report (N001SRR130012).

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FORM 734-C REV. 12-79

CONTENTS

TABLES

FIGURES

FIGURES

I. INTRODUCTION

Various portions of Building 001 at the Headquarters site have been used for fabrication of reactor fuel elements using enriched uranium. This work has most recently been conducted under the NRC Special Nuclear Materials License No. SNM-21.[1] It has been decided to decontaminate this building and related areas at Headquarters, and eliminate them from the license.

Conditions 22 and 46 of the license impose Annex C (attached here as Appendix A) as a requirement for decontamination of facilities and equipment for release for unrestricted use. The requirements of Annex C have been followed. An additional criterion, communicated during telephone discussions between M. E. Remley (ESG) and W. T. Crow (NRC), is the imposition of a limit of 30 pCi U/g soil above natural background subject to the interpretations presented in the Federal Register.[2]

II. IDENTIFICATION OF PREMISES

The premises to be released consist of part of Building 001 at the Headquarters (or De Soto) site. This site is shown in Figure 1. It is located at 8900 De Soto Avenue in Canoga Park, California.

In order to provide an orderly and effective transfer of this building to the Rocketdyne Division of Rockwell International, separate regions have been identified and scheduled for decommissioning, and these have been prepared for release in three phases.

The radiation survey for Phase I was reported in N001SRR130011, "Radiation Survey for Phase I Release for Unrestricted use of ESG Headquarters, Building 001," while the survey for Phase II was reported in N001SRR130012, "Radiation Survey for Phase II Release for Unrestricted Use of ESG Headquarters Building 001."

For Phase III, this survey and report covers a portion of Building 001, designated Regions IIA and III, that is shown in Figure 2, and, additionally, outside areas associated with fuel fabrication, three yards (507, 508, and 511), Building 131, and the roof of Building 001. A mezzanine floor is in the western quarter of Building 001, consisting of an enclosed office area and a partially exposed equipment platform for air conditioning and ventilating equipment and other similar building utilities. Although these mezzanine areas were not subject to contamination during any of the work performed here, the office mezzanine and the southern part of the equipment mezzanine were included in Phase I; most of the northern part of the equipment mezzanine was included in Phase II; the balance is included in Phase III. In many cases, the room identification shown in Figure 2 reflects the past arrangement: many walls have been removed in preparation for renovations.

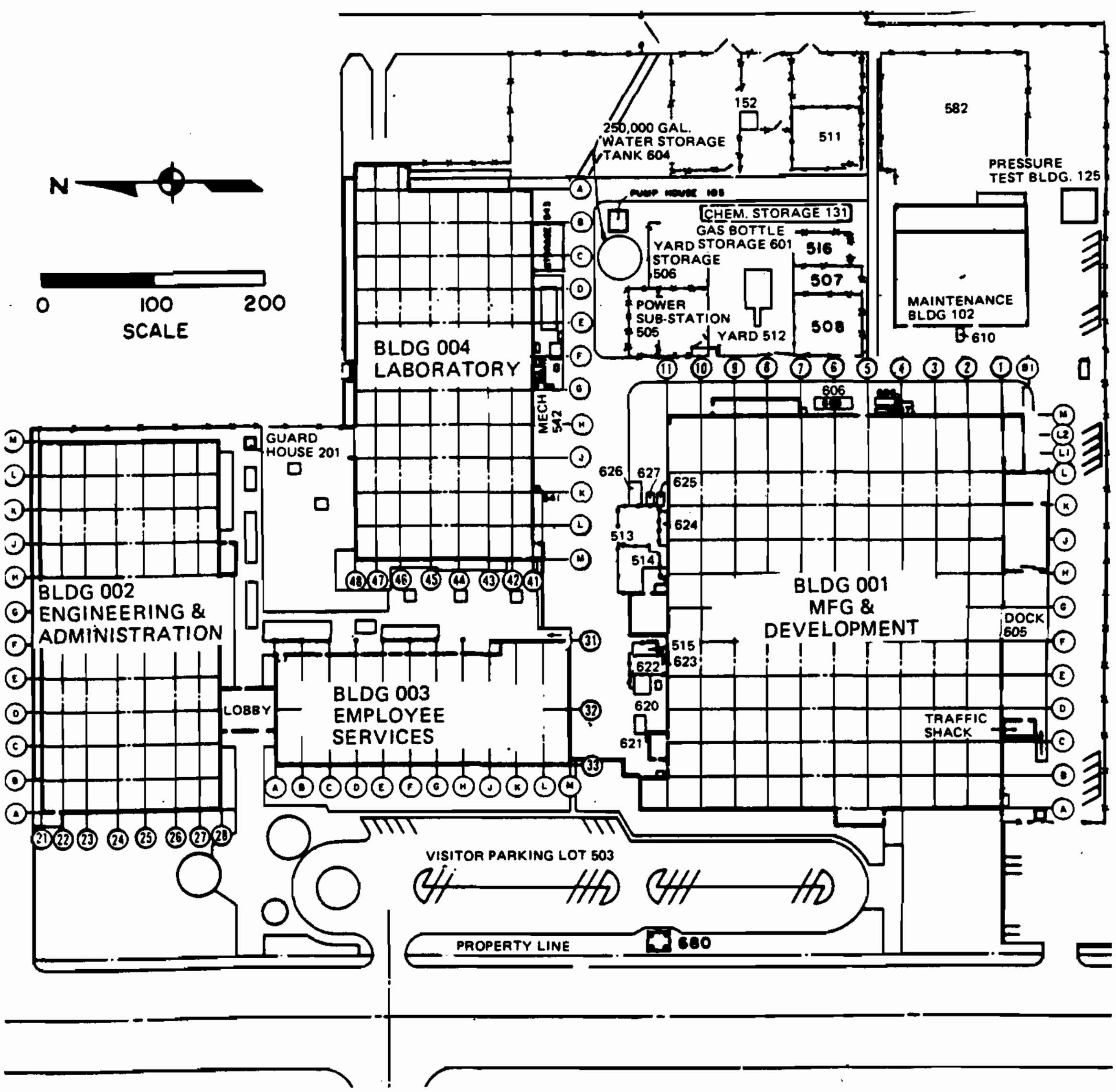

Figure 1. De Soto Avenue (Headquarters) Site in Canoga Park

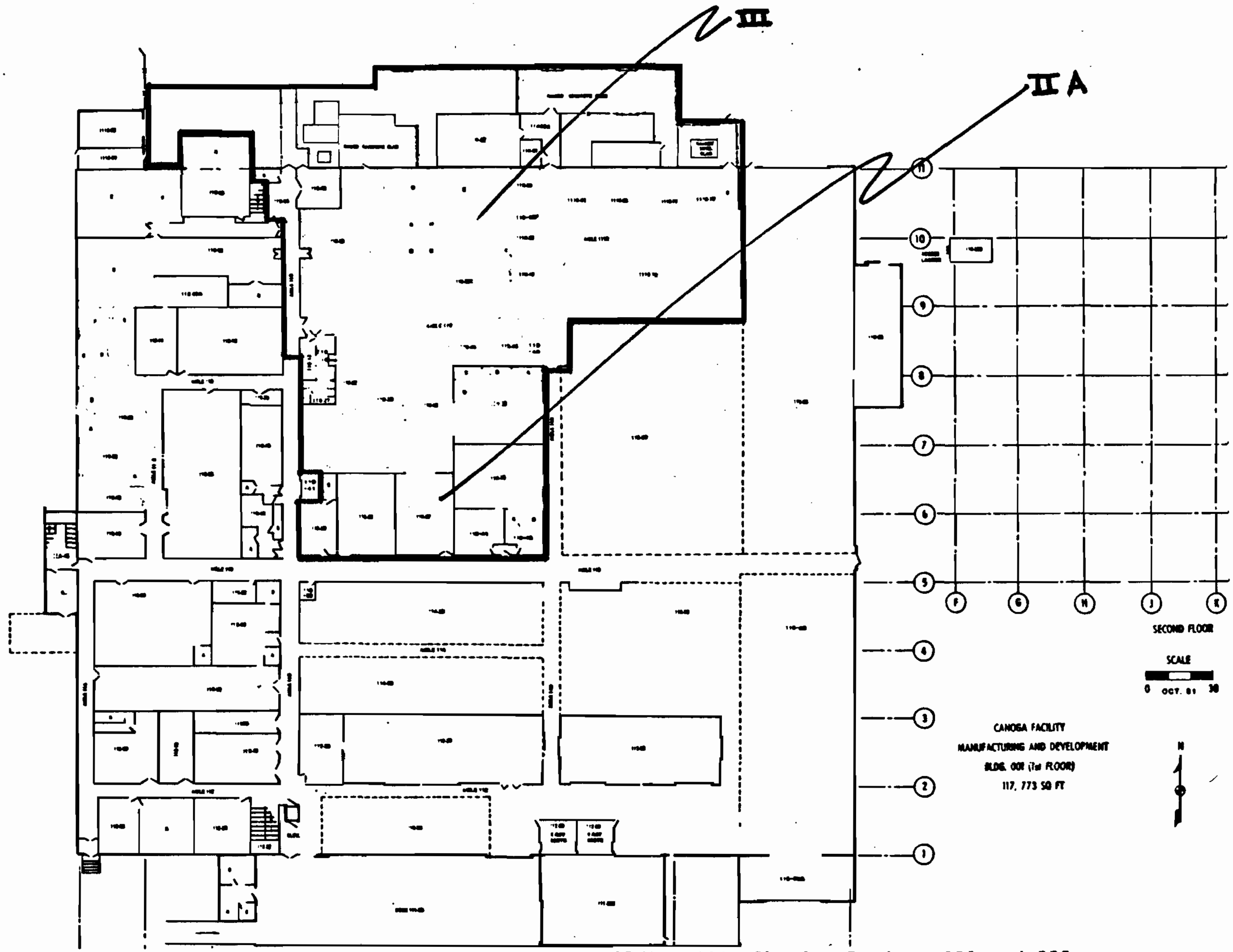

Figure 2. Ground-Floor Layout of Building 001, Showing Regions IIA and III

The separation into two regions (IIA and III) has been a scheduling convenience and does not indicate any significant difference between the regions. Region IIA has been attached to Region III (the fuel fabrication area) in order to provide confinement of airborne contamination.

The outside areas were used for storage of waste packages, and include the contaminated wastewater holdup tank pits.

Yards 507 and 508 had been used, a long time ago, for storage of shipping containers. They have been in use more recently for miscellaneous industrial storage (Yard 507) and for a spray paint booth (Yard 508).

Yard 511 had been used during the recent fuel fabrication program for storage of waste packages, prior to shipment.

Building 131 had been used for packaging and storage of clean and used protective clothing for the fuel fabrication program.

The roof included several radioactive exhaust filter systems that were removed during the decontamination operations.

III. DECONTAMINATION EFFORTS

Region III was used for fabrication of a variety of reactor fuel elements using a broad range of uranium enrichments from about 2% to 93%. This work began in 1959. Uranium fabrication in this area was completed in October 1982. Region IIA consisted of offices, a tool crib, and warehouse space, but had previously housed areas in which enriched uranium was used.

Decontamination of this area was accomplished by removing all equipment, cleaning and removal of walls and utilities, removal of all floor covering (with concrete scabbling in some cases), and air blowing, vacuuming and hand wiping. During this work, surveys were performed with GM pancake survey instruments and alpha scintillator survey instruments. All surfaces exceeding the acceptance criteria (Appendix A) were cleaned or disposed of as radioactive waste.

In the outside area, some drain lines and the holdup tanks were removed. Some scabbling was required in the tank pits.

The only decontamination work required on the roof was the removal of the exhaust filter systems.

The yards and Building 131 were not found to be contaminated and no special decontamination work was required.

All radioactive wastewater drain lines were removed in the current decontamination project by saw-cutting the concrete floor, digging out the soil overburden, and disposing of the drain pipes as radioactive waste. Additional soil was dug out below the pipe level to provide a clean trench surface and easily sampled dirt piles and to remove soil found to be contaminated. The drain lines and small amounts of soil were disposed of as radioactive waste. The arrangement of trenches is shown in Figure 3. Some of these were backfilled with soil after sampling and analysis by ESG had shown the soil

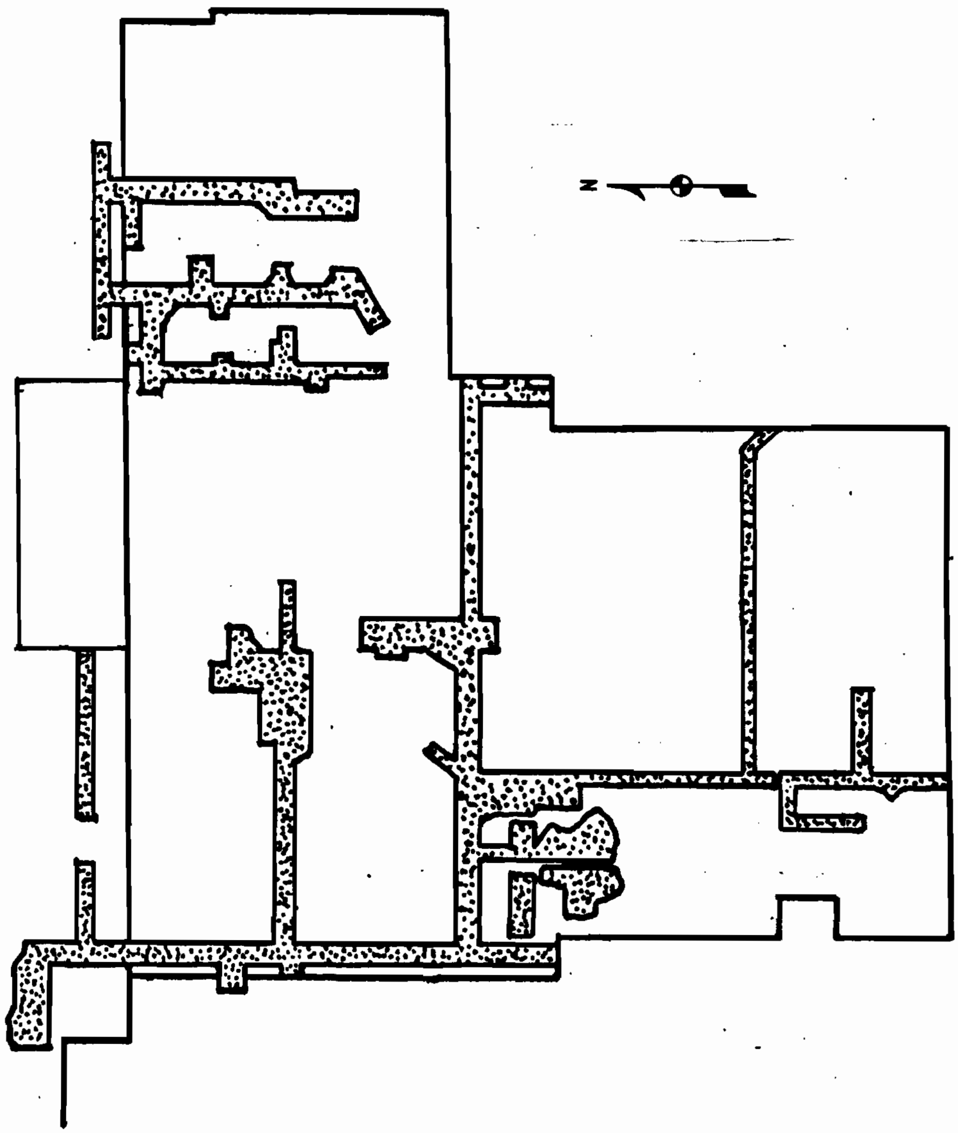

Figure 3. Regions IIA and III Showing Arrangement of Trenches for Removal of Radioactive Waste Liquid Drain Lines

activity to be below the acceptance limit. NRC had independently sampled the trenches and soil prior to this backfilling, and completed soil sampling on November 9.

As a final step, a general housecleaning was performed to remove the overall deposits of industrial dust and grime from structural and utility surfaces.

IV. SURVEY SCOPE AND PROCEDURES

A. SURVEY SCOPE

A sampling inspection plan using variables has been used to demonstrate that the residual contamination in the area is below the following limits:

Total average over 1 m^2	5000 dpm α/100 cm^2
Total maximum over 100 cm^2	15000 dpm α/100 cm^2
Removable	1000 dpm α/100 cm^2
Soil	30 pCi U/g soil in excess of naturally present uranium

The sampling inspection plan that was used is based upon a uniform 3-meter (10-ft) square grid superimposed on the area as shown in Figure 4. A 3-m-square grid has been adopted to be consistent with NRC and State of California guidance. (As shown in these figures, this grid is illustrative only; the actual grid in each room was benchmarked in the northwest corner of the room. An identical grid was reflected onto the ceiling. A similar grid structure was also applied to the walls, benchmarked in the upper left corner of each wall. Each survey area has been identified with codes indicating the surface (F = floor; C = ceiling; N, E, S, W = north, east, south, west walls, respectively) and a two-figure Cartesian coordinate showing the distance in meters from a local benchmark.

Within each square defined by the grid lines, a single 1-m^2 area was surveyed. Each area was outlined by felt marker or paint, with its coordinates marked within or beside the 1-m^2 area. The location of this 1-m^2 area was left to the surveyor's judgment: it was to be the area that, in his judgment, was most likely to have retained the most residual contamination of any similar area within the grid square. The surveyor was instructed to do this conscientiously to assure that any significant residual contamination would be detected before a report of acceptability was made to a regulatory agency. The use of a predetermined grid with discretion for the exact

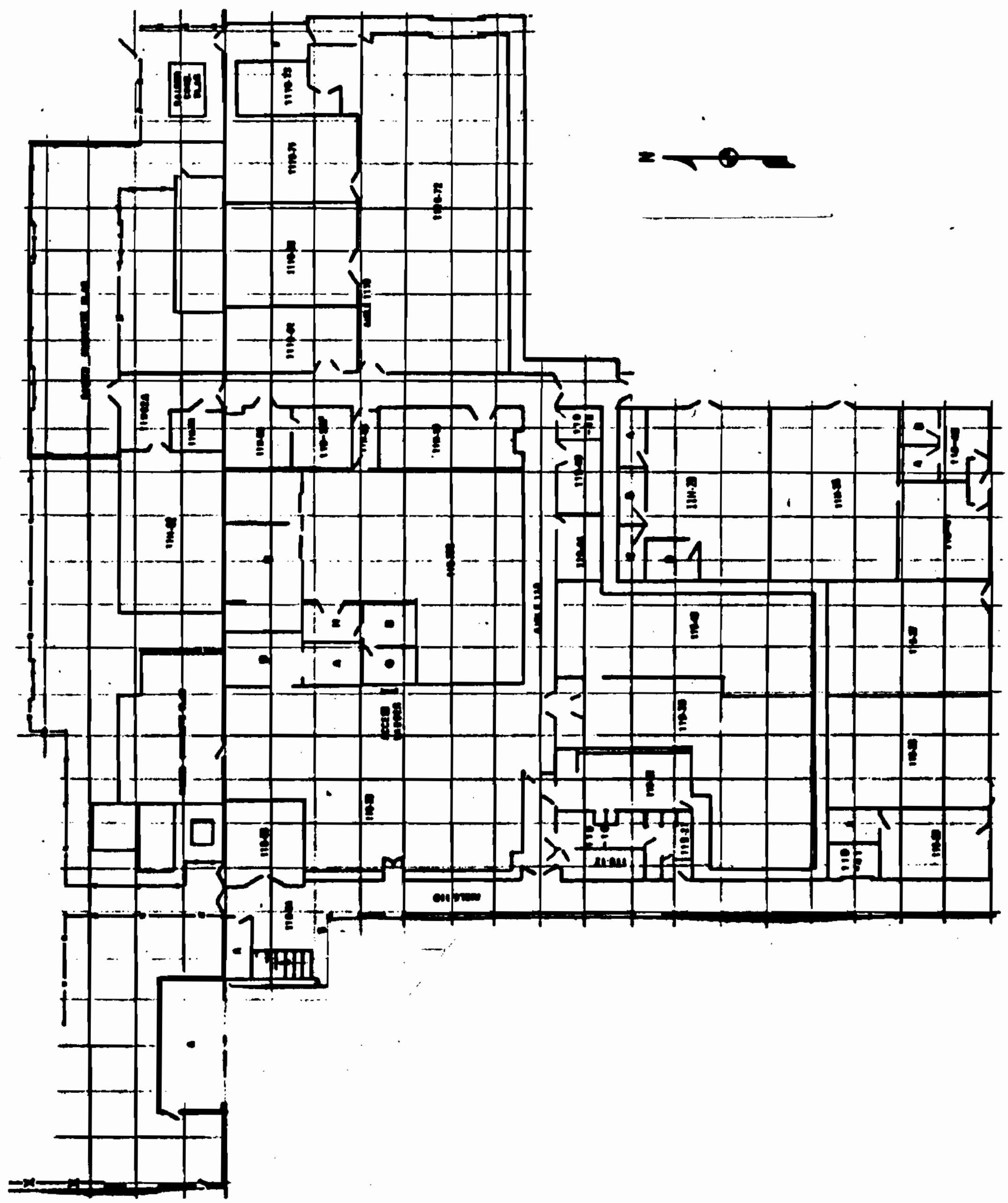

Figure 4. Regions IIA and III Showing Overlay of
3-m (10 ft) Square Grid Used for Survey

location provides a biased-uniform survey; Selection of one 1-m^2 area out of the nine within each grid square provides an 11% sampling of the surface; selection of one 1-m^2 area for every other grid square provides a 5.5% sampling.

Sampling inspection consists of a <u>sampling plan</u> for selection of items to be tested, in this case, locations to be measured for radioactivity, and the method of analysis, and a <u>plan of action</u>, establishing the acceptance/ rejection criteria. The <u>sampling plan</u> used for this phase was to inspect one 1-m^2 area out of every 3-m grid square throughout the regions.

The 1-m^2 area is first measured for total activity and then for removable activity.

The values resulting from these measurements (converted to the proper units) are analyzed in the following manner:

The test statistic $\bar{x} + ks$ is compared to the acceptance limit U,

where

$\bar{x}$ = average (arithmetic mean of measured values)
s = observed sample standard deviation
k = tolerance factor calculated from the number of samples to achieve desired sensitivity for this test
U = acceptance limit.

The State of California has stated[3] that the consumer's risk of acceptance (β) at 10% defective (LTPD, Lot Tolerance Percent Defective) must be 0.1. For these choices of β and LTPD, $K_\beta = K_2 = 1.282$. The number of samples is n. Values of k for each sample size are calculated from[4]:

$$k = \frac{K_2 + \sqrt{K_2^2 - ab}}{a}; \quad a = 1 - \frac{K_\beta^2}{2(n-1)}, \quad b = K_2^2 - \frac{K_\beta^2}{n} .$$

For example, for n = 10, k = 2.41; n = 100, k = 1.47; n = 1000, k = 1.34.

The criteria for acceptance are presented as a plan of action. The plan of action is:

1) Acceptance: If the test statistic ($\bar{x}$ + ks) is less than or equal to the limit (U) accept the region as clean. (If any single measured value exceeds the limit, decontaminate that location to below the limit, but do not change the value in the analysis.)
2) Collect additional measurements: If the test statistic ($\bar{x}$ + ks) is greater than the limit (U), but $\bar{x}$ itself is less than U, independently resample and combine all measured values to determine if $\bar{x} + ks \leq U$ for the combined set; if so, accept the region as clean. If not, reject the region.
3) Rejection: If the test statistic ($\bar{x}$ + ks) is greater than the limit (U) and $\bar{x} \geq U$, reject the region.

The specifications of the sampling plan assure that a reasonable number of locations will be inspected so that the data will be representative, but not an excessive number so that the effort may be reasonably expended. The plan of action assures (by Step 1) that the general level of contamination is confidently below the acceptance limit, while it guarantees that no area known to be contaminated in excess of the limit remains so. (It is important that the new measurement of contamination at that location not be entered in the data set used for the acceptance test since it represents special treatment not afforded to the rest of the region.)

Step 2 takes advantage of the improved discrimination of the acceptance test resulting from an increase in the number of samples to reduce the risk of rejecting a region that is acceptably clean. This false rejection should be avoided if possible to avoid the unnecessary expense of further decontamination. If the result of the additional inspection does not show acceptability, further decontamination is required.

Step 3 assures that no truly contaminated area will be accepted. The contamination measurements made at the inspected location may be used to guide further decontamination, but these locations should be avoided in the subsequent inspection.

B. PROCEDURES

The following procedures were used in performing this survey.

1. Average Contamination Measurement

1) Identify 1-m^2 area to be measured.
2) With a portable scaler (Technical Associates FS-8 or equivalent) set for 5-min count time, use an alpha probe (Ludlum Model 43-1 or equivalent) or a beta probe (Ludlum Model 44-9 or Associates Model P-11 or equivalent) and uniformly scan the area. (Watch for and note any "hot spots" where the radioactivity may exceed the average limit. These are to be resurveyed later.)
3) Record the location and total count.
4) The total count is converted to dpm/100 cm^2 total surface activity by:

$$SA_T = \left(\frac{C - B}{5}\right)E\left(\frac{100}{A}\right)$$

where

SA_T = total surface activity in dpm/100 cm^2
C = total count in 5 min
5 = count time, min
B = background count in 5 min (generally 0-5 for alpha and about 200-220 for beta)
E = efficiency factor, dpm/cpm (generally 4 for alpha and 7 for beta)
100 = 100 cm^2 standard area
A = probe sensitive area (69 cm^2 for Ludlum Model 43-1 alpha scintillator; 20 cm^2 for Ludlum Model 44-9 and Technical Associates Model P-11 pancake G-M).

(Note that the analysis is done using counts rather than count rates.)

2. Maximum Contamination Measurement

1) Return to any area identified as having a "hot spot."
2) Repeat the uniform scan of only the hot spot area, covering approximately 100 cm^2 with the probe.
3) Record the location and total count, as a "hot spot" measurement.
4) The total count is converted to dpm/100 cm^2 as shown above.

3. Removable Contamination Measurement

1) Identify 1-m^2 area to be measured.
2) Using a Whatman 540 filter paper (2.4 cm diameter), wipe a "Z" or "S" pattern, with legs approximately 6 in. long, so as to sample removable contamination from an area of approximately 100 cm^2.
3) Place smear paper in file card "book" until ready for counting.

4) Count radioactivity using gas-flow proportional counter (NMC Model ACS-77 or equivalent) for 5 min.
5) Record the location and both the total alpha count and the total beta count.
6) The total counts are converted to dpm/100 cm^2 removable surface activity by:

$$SA_R = \left(\frac{C - B}{5}\right)E$$

where the appropriate alpha and beta backgrounds and efficiency factors are used. Backgrounds are typically 1-3 counts for alpha and 120-150 counts for beta. Efficiency factors are about 4 dpm/cpm for alpha and beta.

4. Soil Contamination Measurement

1) Identify 1-m^2 area to be measured.
2) Collect approximately 5 lb of soil (avoid large rocks, concrete rubble, re-bar, and similar nonsoil material).
3) Dry on hot plate or in microwave oven.
4) Tumble in ball mill jar with suitable number of balls to homogenize the soil.
5) Pass through No. 20 sieve, collecting soil in pan.
6) Place 2 grams of soil in a counting planchet, wet with alcohol to distribute well, and allow to dry.
7) Count in gas-flow proportional counter (Canberra low-background alpha-beta counting system or equivalent) for 30 min.
8) Record location and total counts.
9) The total counts are converted to pCi/g distributed soil activity by:

$$SA_S = \left(\frac{C - B}{30}\right)E'$$

where E' for alpha is determined from counts of spiked soil and sand and is approximately 30 pCi/g per cpm and E' for beta is determined from counts of 2 g KCl, with a specific activity of 831 dpm/g (374 pCi/g), and is approximately 1.5 pCi/g per cpm.

C. CALIBRATION OF INSTRUMENTS

Instruments are calibrated by measuring the instrument background for a 5-min count, and the count for an electroplated U-235 alpha source or electroplated Tc-99 beta source. The scalers indicate 1 count per event detected in the detector and the efficiency factor (dpm/cpm) is calculated as the ratio of 2 times the 2π emission rate of the source (dpm) to the net count rate of the instrument (cpm).

The radioactivity of the calibration sources is traceable to NBS. The KCl is reagent-grade with a calculated value for the specific activity. The spiked soil was prepared by adding a measured mass of highly enriched uranium, in solution, to a measured mass of average local soil. The activity was determined by calculation from the isotopic composition and was confirmed by later analysis by NRC. The calculated activity was 40 pCi/g; the net additional activity measured by NRC was 40.07.

D. SOIL RADIOACTIVITY ANALYSIS

The method for analyzing soil activity used by NRC differs markedly from that used by ESG. Samples of soil are sent by NRC to the Radiological and Environmental Sciences Laboratory at the Idaho National Engineering Laboratory (INEL). The soil samples are acid-leached, and the uranium is chemically extracted and separated from other alpha-emitting elements. The uranium is then deposited and alpha-counted to determine the uranium activity per gram. This method of analysis includes all naturally occurring uranium but excludes all other natural alpha emitters.

The ESG method simply involves alpha counting a plancheted soil sample and includes all alpha emitters in the uranium and thorium decay chains.

A cross-calibration between the two methods has been done using samples of natural (uncontaminated) soil, a calibration standard, and samples of contaminated soil taken by NRC during this decommissioning operation, and split with ESG.

Radioactivity concentration values reported by ESG (alpha pCi/g) and NRC (uranium pCi/g) for these samples are shown in Figure 5.

Most of the residual soil analyzed is uncontaminated and its background activity is easily determined. Background activity in the soil sampled from Building 001 is 18.0 pCi α/g. The limit is therefore 48 pCi α/g. The corresponding uranium background activity is 3.3 pCi U/g and the NRC limit is therefore 33 pCi U/g. A linear least-squares fit to the results shown in Figure 5 gives:

$$\text{NRC (U pCi/g)} = (-9.9 \pm 3.8) + (0.86 \pm 0.11)\ \text{ESG } (\alpha\ \text{pCi/g})$$

This analytic expression is shown as a solid line, with $\pm 1\sigma$ confidence limits shown above and below as dashed lines. The lines curve as a result of plotting a linear function on a log-log graph.

E. "UNUSUAL" FEATURES

Manufacturing buildings frequently have unusual features, such as pits, machine foundations and trenches, small storage areas, and similar places that, because of their uniqueness, do not fit well in a sampling inspection plan. However, as a result of their uniqueness, they attract suspicion even more so than contamination. Features of this sort in Regions IIA and III were checked qualitatively with survey instruments (countrate meters) and smears. Yards 507 and 508 and Building 131 were also treated in this manner. No indications of contamination were found.

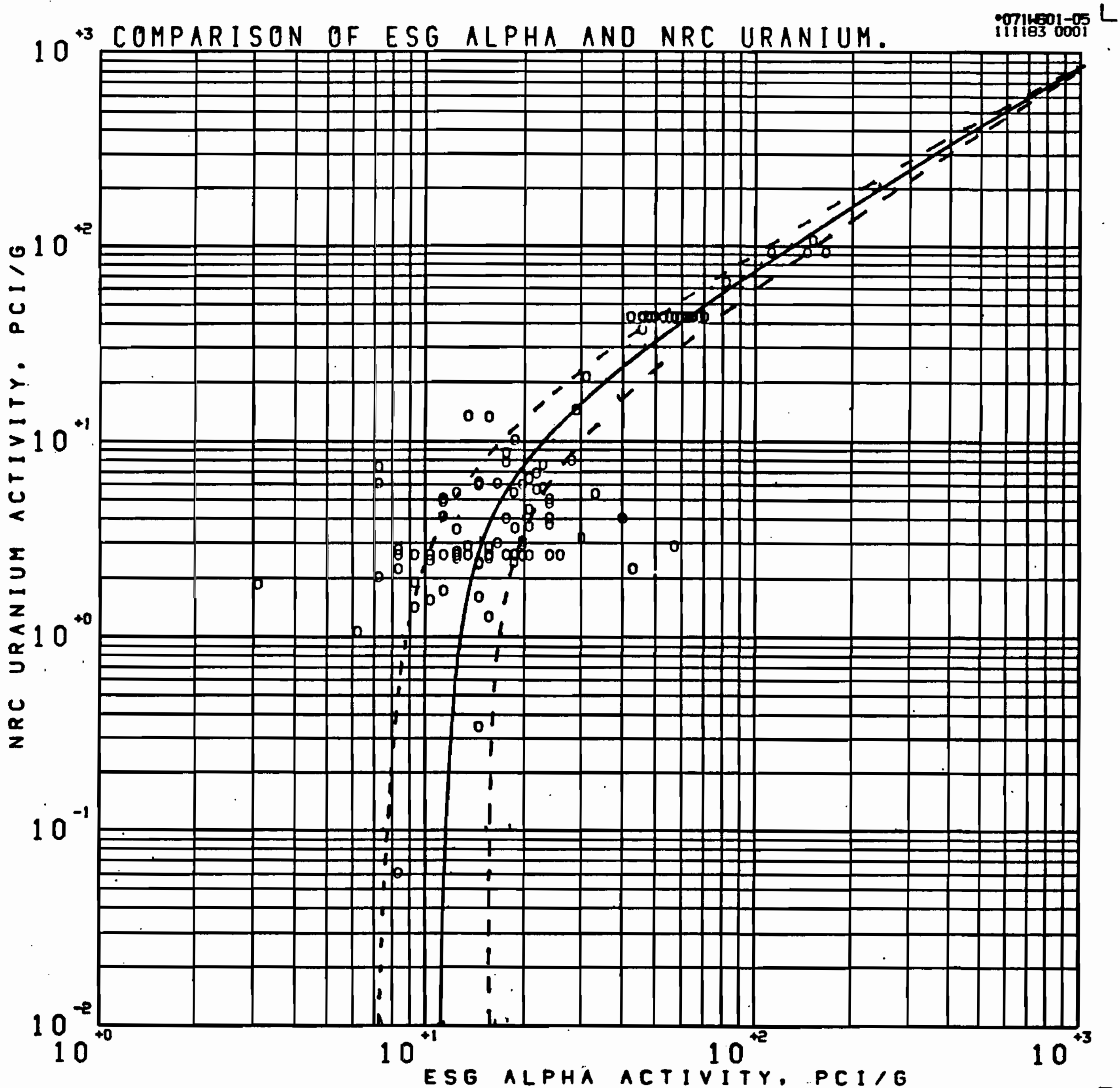

Figure 5. Comparison of NRC and ESG Soil Analysis Results

V. SURVEY RESULTS

Since unencapsulated material had been used and contamination had been found exceeding the release criteria prior to decontamination in Regions IIA and III, 10% inspection was used for alpha and for beta. Some ceiling areas, with little chance of contamination, were sampled at a 5% rate. Because of the difference in usage, the outside areas, the roof, and Yard 511 were surveyed separately. The results are summarized in Tables V-1a through d, while all data are displayed in Figures 6 through 31, relative to the mean value of each type of measurement.

The "Inspection Test Statistic" is $\overline{x} + ks$, which must be less than the limit.

TABLE V-1a
SUMMARY OF SURVEY RESULTS
REGIONS IIA and III

Measurement	Number of Locations	Average Value	Maximum Value	Inspection Test Statistic	Limit	Test Result
Average alpha	940	23	606	89	5,000	Accept
Maximum alpha	5	539	910	**	15,000	Accept
Removable alpha	940	1	74	5	1,000	Accept
Alpha soil activity	127	20	44	29	48	Accept
Average beta	940	416	3,423	1,302	5,000	Accept
Maximum beta	8	32,248	110,000	**	15,000	Reclean
Removable beta	940	2	89	22	1,000	Accept
Beta soil activity	127	24	30	28	100*	Accept

*No requirement for beta activity in soil has been established. The value assumed here as a limit has been used in DOE decommissioning projects.
**Insufficient number of data values to apply statistical test. All detected hot spots were specifically removed after the survey.

With the exception of three beta "hot spots," found in the fuel element machine shop area, which exceeded the allowable limit and were decontaminated immediately after detection, all data and inspection test statistic values are well below the limits. These results confirm that the area is acceptable for release for unrestricted use.

TABLE V-1b

SUMMARY OF SURVEY RESULTS
OUTSIDE AREAS

Measurement	Number of Locations	Average Value	Maximum Value	Inspection Test Statistic	Limit	Test Result
Average alpha	141	40	246	103	5,000	Accept
Maximum alpha	10	541	1,462	**	15,000	Accept
Removable alpha	129	1	5	3	1,000	Accept
Alpha soil activity	0	--	--	--	48	Accept
Average beta	141	1,337	4,531	2,090	5,000	Accept
Maximum beta	9	23,173	94,600	**	15,000	Reclean
Removable beta	129	5	58	24	1,000	Accept
Beta soil activity	0	--	--	--	100*	Accept

*No requirement for beta activity in soil has been established. The value assumed here as a limit has been used in DOE decommissioning projects.

Two beta "hot spots" exceeding the allowable limit were found in the outside area. These were cleaned immediately after detection.

TABLE V-1c

SUMMARY OF SURVEY RESULTS
ROOF

Measurement	Number of Locations	Average Value	Maximum Value	Inspection Test Statistic	Limit	Test Result
Average alpha	28	31	72	69	5,000	Accept
Maximum alpha	0	--	--	--	15,000	Accept
Removable alpha	28	-1	2	1	1,000	Accept
Alpha soil activity	--	--	--	--	48	Accept
Average beta	28	647	1,747	1,700	5,000	Accept
Maximum beta	0	--	--	--	15,000	Accept
Removable beta	28	1	27	22	1,000	Accept
Beta soil activity	--	--	--	--	100*	Accept

*No requirement for beta activity in soil has been established. The value assumed here as a limit has been used in DOE decommissioning projects.

TABLE V-1d
SUMMARY OF SURVEY RESULTS
YARD 511

Measurement	Number of Locations	Average Value	Maximum Value	Inspection Test Statistic	Limit	Test Result
Average alpha	43	7	20	19	5,000	Accept
Maximum alpha	0	--	--	--	15,000	Accept
Removable alpha	43	-1	2	0.8	1,000	Accept
Alpha soil activity	4	19	34	**	48	Accept
Average beta	43	2,321	4,096	3,513	5,000	Accept
Maximum beta	0	--	--	--	15,000	Accept
Removable beta	43	-2	20	15	1,000	Accept
Beta soil activity	4	26	28	**	100*	Accept

*No requirement for beta activity in soil has been established. The value assumed here as a limit has been used in DOE decommissioning projects.
**Insufficient number of data values to apply statistical test.

The final survey of Yard 511 was done while some radioactive material (activated metallurgical samples) was still in Building 131, adjacent to the yard. This material produced a radiation field in the yard that exceeded natural background by up to 45 μR/hr. This artificially elevated all of the average beta measurements using a pancake G-M detector. (The alpha scintillator and the smears for removable alpha and beta are not affected by gamma radiation.) After this material had been moved to a thoroughly shielded storage facility in Building 004, the half of Yard 511 close to Building 131, which had the greatest perturbation from the radioactive material, was resurveyed. Thus, the set of average beta values includes both true readings and some remaining perturbed values. The analysis therefore overestimates the actual radioactivity of this yard, but the results are nevertheless acceptable.

Figures 6 through 31 provide a convenient way of reviewing all the survey data from a particular type of measurement, in context with the full set of data and relative to the limit. The method of display chosen for the data is similar to the log-normal probability display frequently used for radiometric data with two exceptions: The abcissa scale is in standard deviation units rather than cumulative percent, and a linear, rather than logarithmic, representation has been used. This method allows presentation of data that are distributed according to the familiar "bell-shaped" Gaussian curve as a straight line. The closer to the straight line that the data points are, the better the fit of a Gaussian distribution to the sample. Even for cases in which the actual distribution is not close to Gaussian, this method provides a useful presentation, just as data that are not from a logarithmic function may be plotted on a log-log, or semilog graph.

The relation between the standard deviation scale and cumulative percent is

Standard Deviations	Cumulative Percent
-4.0	0.0032
-3.0	0.13
-2.0	3.3
-1.0	15.9
0.0	50.0
1.0	84.1
2.0	97.7
3.0	99.87
4.0	99.9968

A logarithmic representation is not satisfactory in this case because the areas surveyed are so clean that the results are scattered about zero, with negative and zero values as well as positive values.

The upper limit on the ordinate scale (activity) was set equal to the acceptance limit for each type of measurement. On each graph, a vertical line is drawn (terminating in an "X" at or near the upper edge at the acceptance limit) indicating the value of the k-factor for the statistical test. For the area to have passed the sampling inspection test, the line drawn through the data points must pass below the X, and there must be no values remaining that exceed the limit.

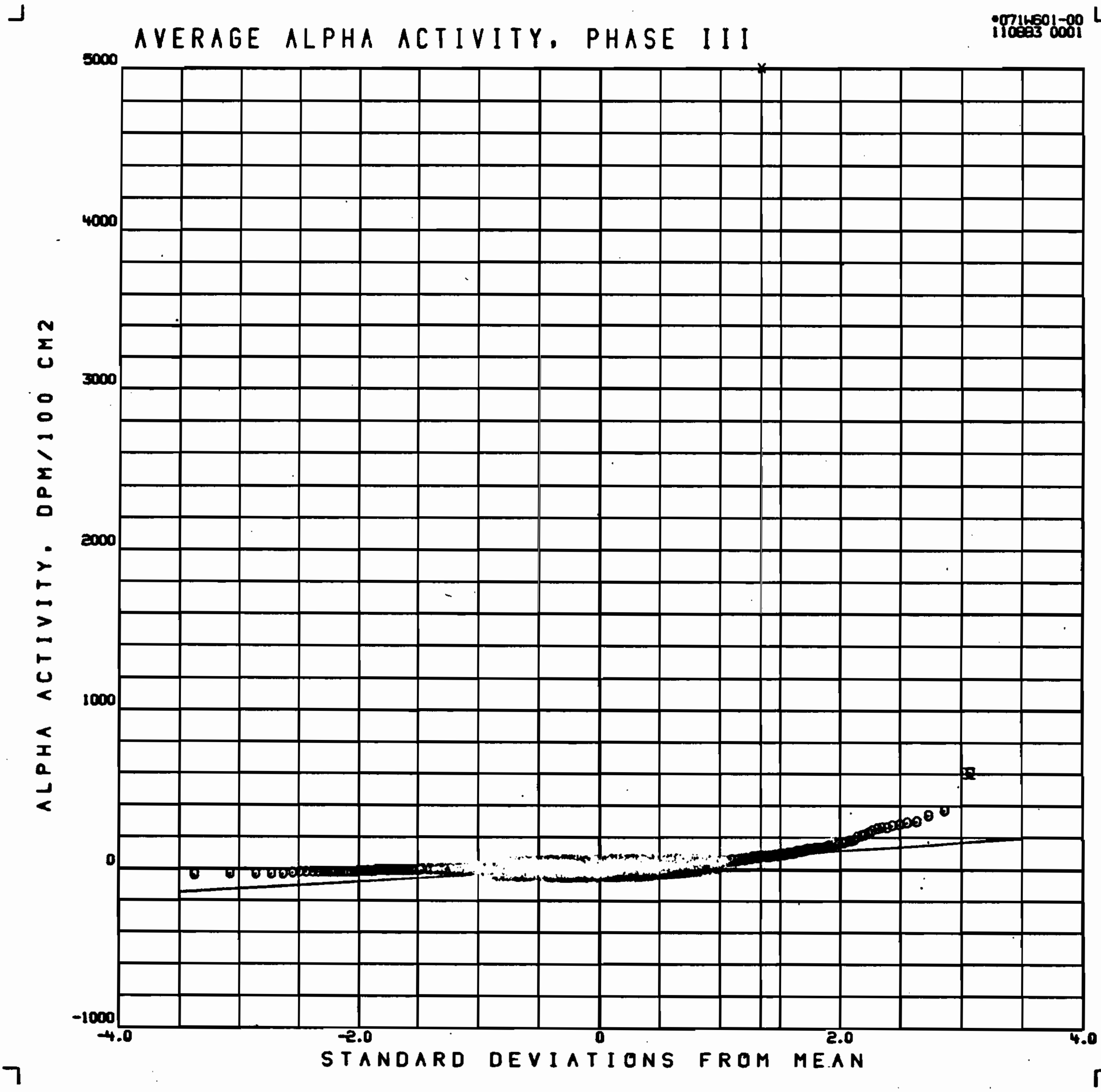

Figure 6. Cumulative Probability Plot for Average Alpha Contamination in Regions IIA and III

Five "hot spots" were identified by the surveyors as having a concentrated area of alpha radioactivity. The locations and values were:

Room	Grid	Surface Activity (dpm/100 cm^2)
1110-61	F2, 6	910
1110-61	F1, 8	686
1110-72	F2, 10	486
1110-72	F3, 20	310
1110-72	F8, 9	305

Each spot was removed after being detected.

Figure 7. Maximum Alpha Contamination in Regions IIA and III

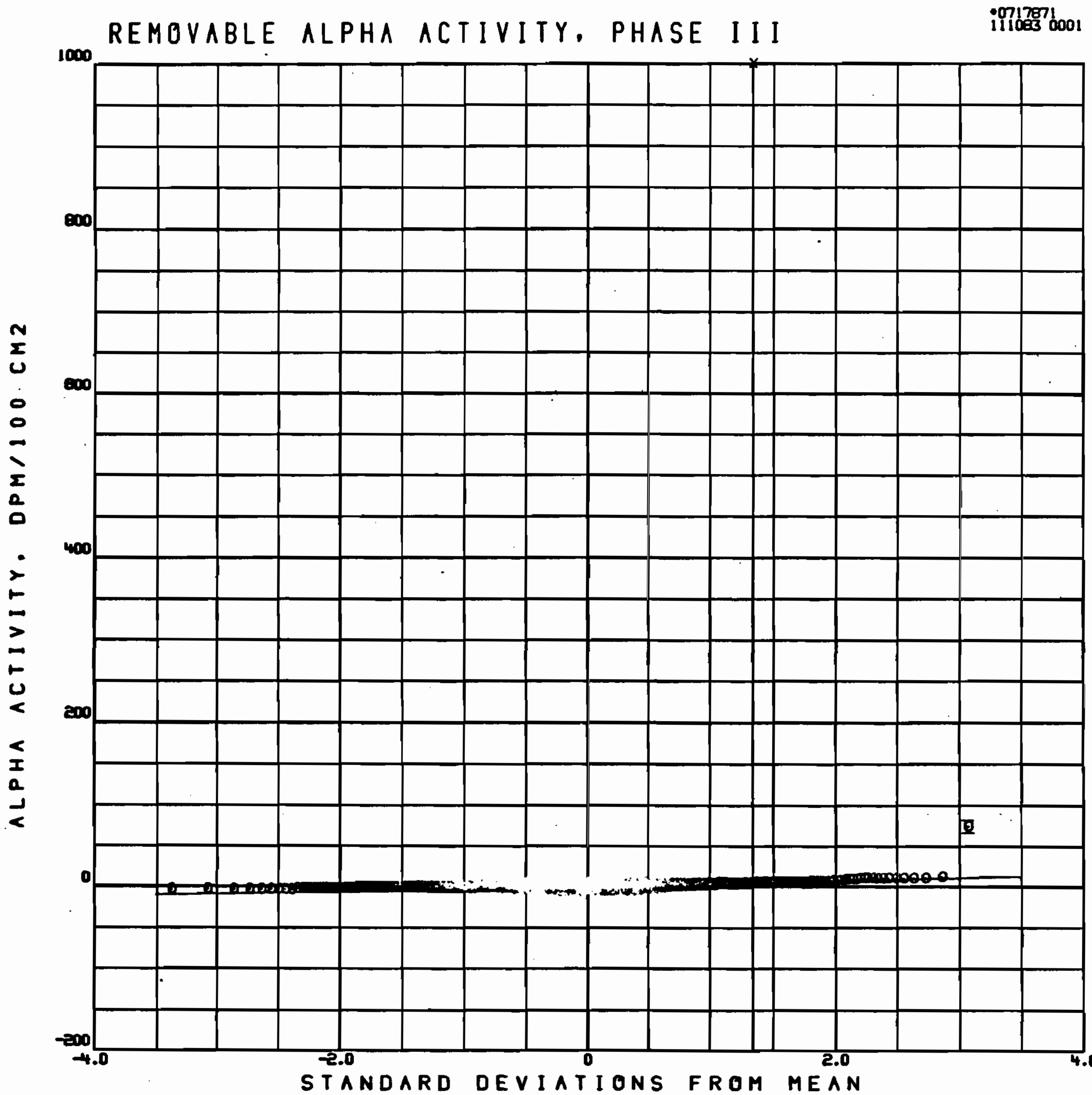

Figure 8. Cumulative Probability Plot for Removable Alpha Contamination in Regions IIA and III

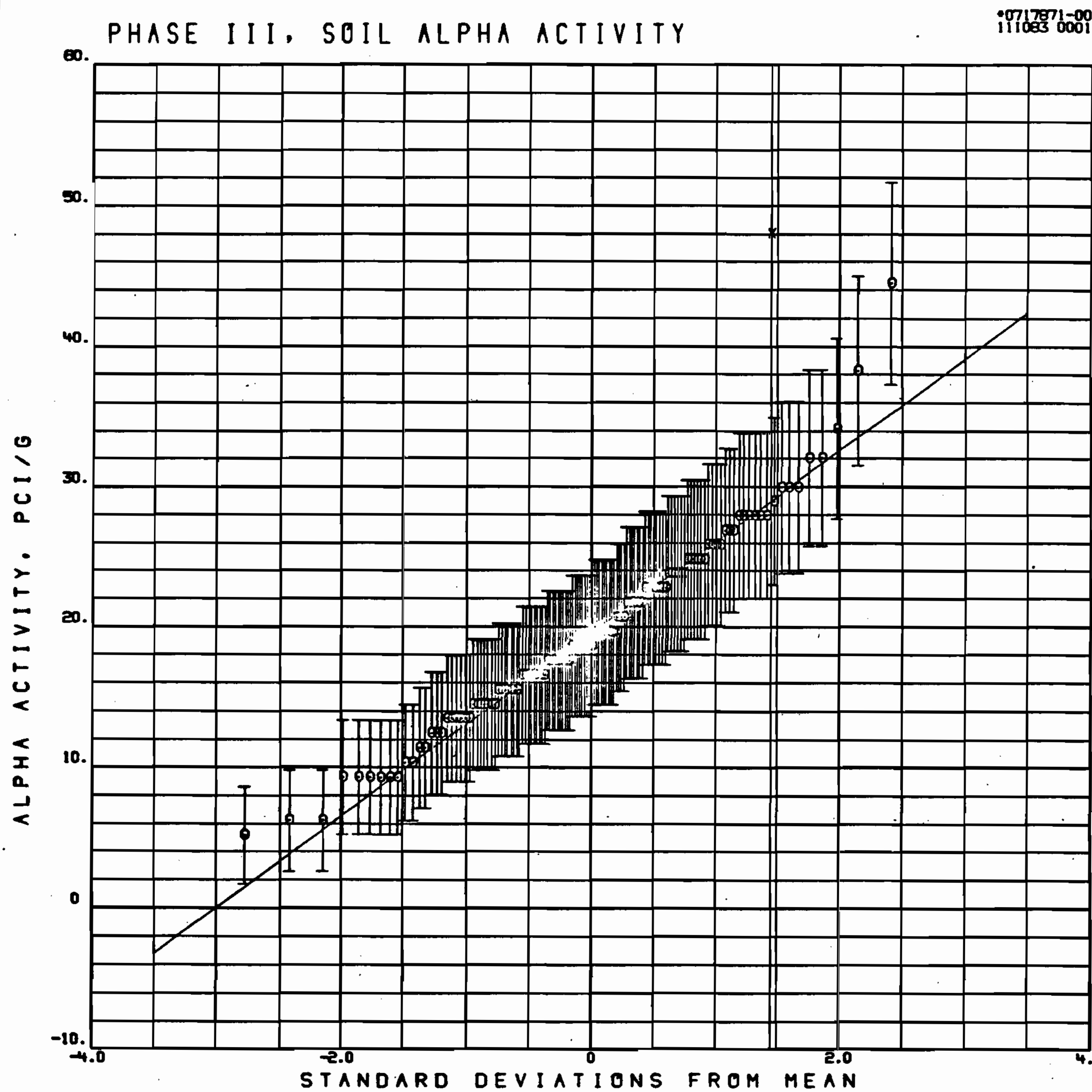

Figure 9. Cumulative Probability Plot for Alpha Soil Activity in Regions IIA and III

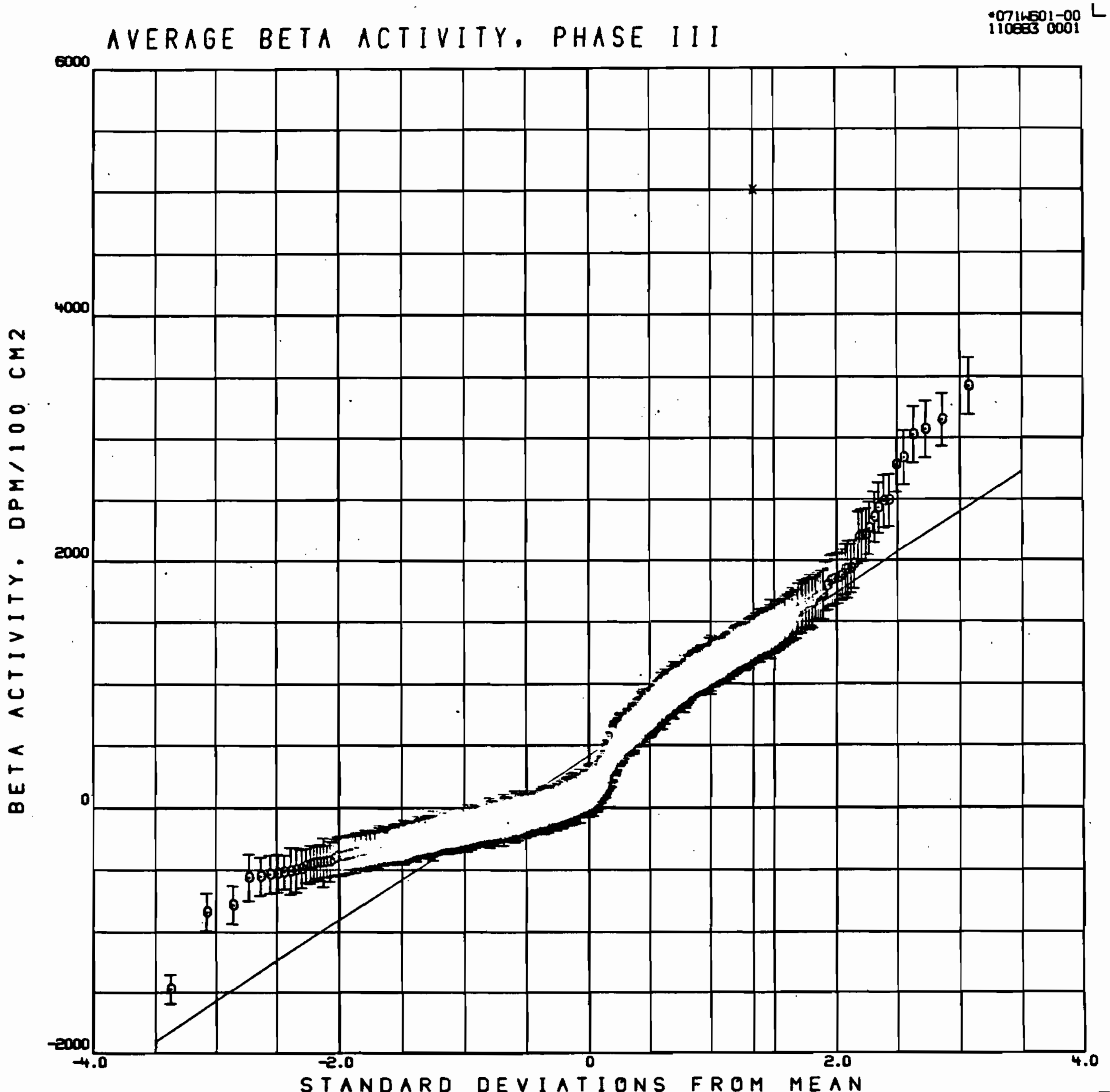

Figure 10. Cumulative Probability Plot for Average Beta Contamination in Regions IIA and III

Eight "hot spots" were identified by the surveyors as having a concentrated area of beta radioactivity. The locations and values were:

Room	Grid	Surface Activity (dpm/100 cm^2)
1110-72	F5, 12	110082
1110-61	F2, 6	2605
1110-61	F1, 8	3003
1110-72	F2, 10	14450
1110-72	F3, 20	12774
1110-72	F8, 9	2168
1110-72	"	72800
1110-65	F10, 7	40106

Each spot was removed after being detected.

Figure 11. Maximum Beta Contamination in Regions IIA and III

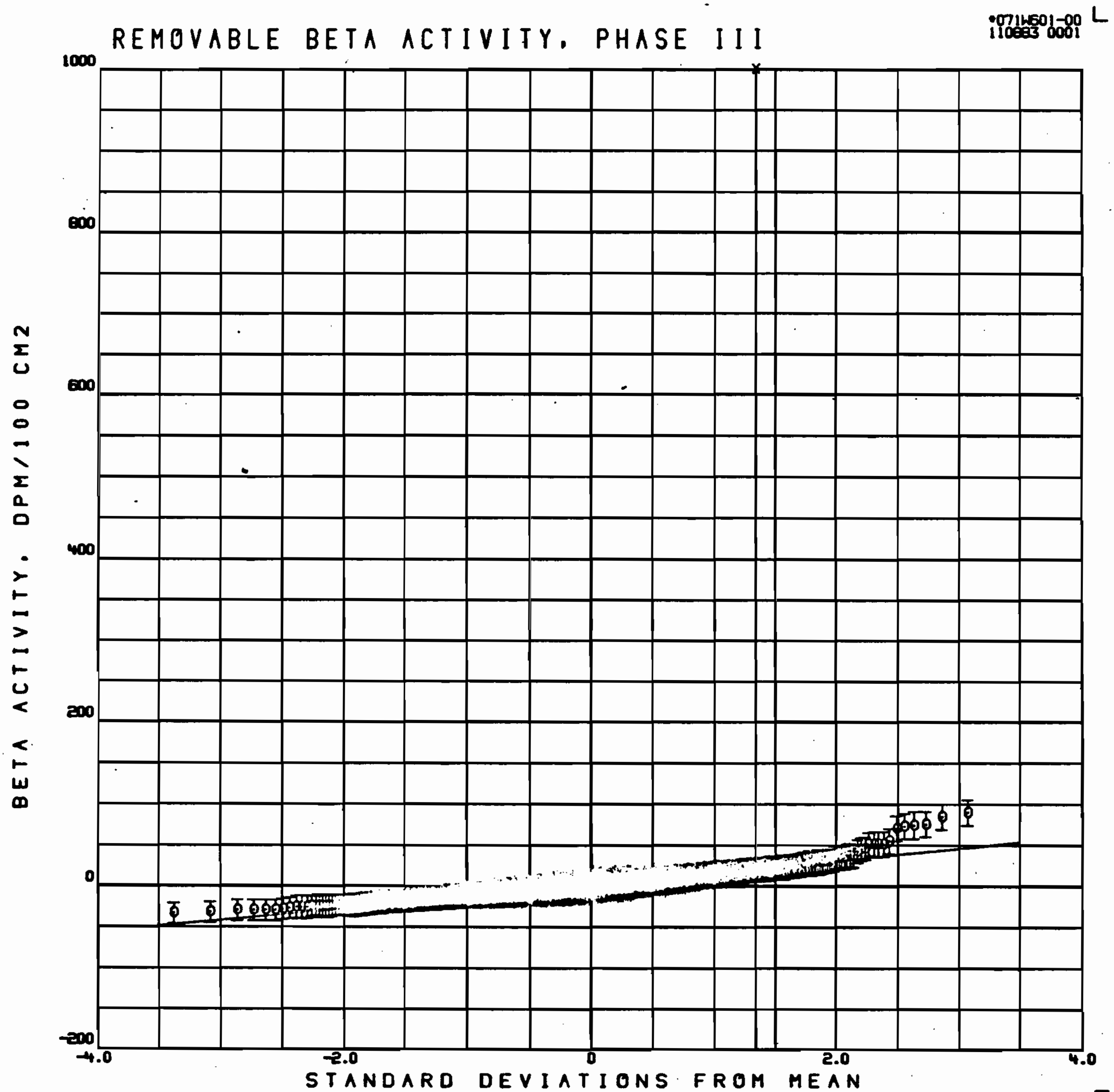

Figure 12. Cumulative Probability Plot for Removable Beta Contamination in Regions IIA and III

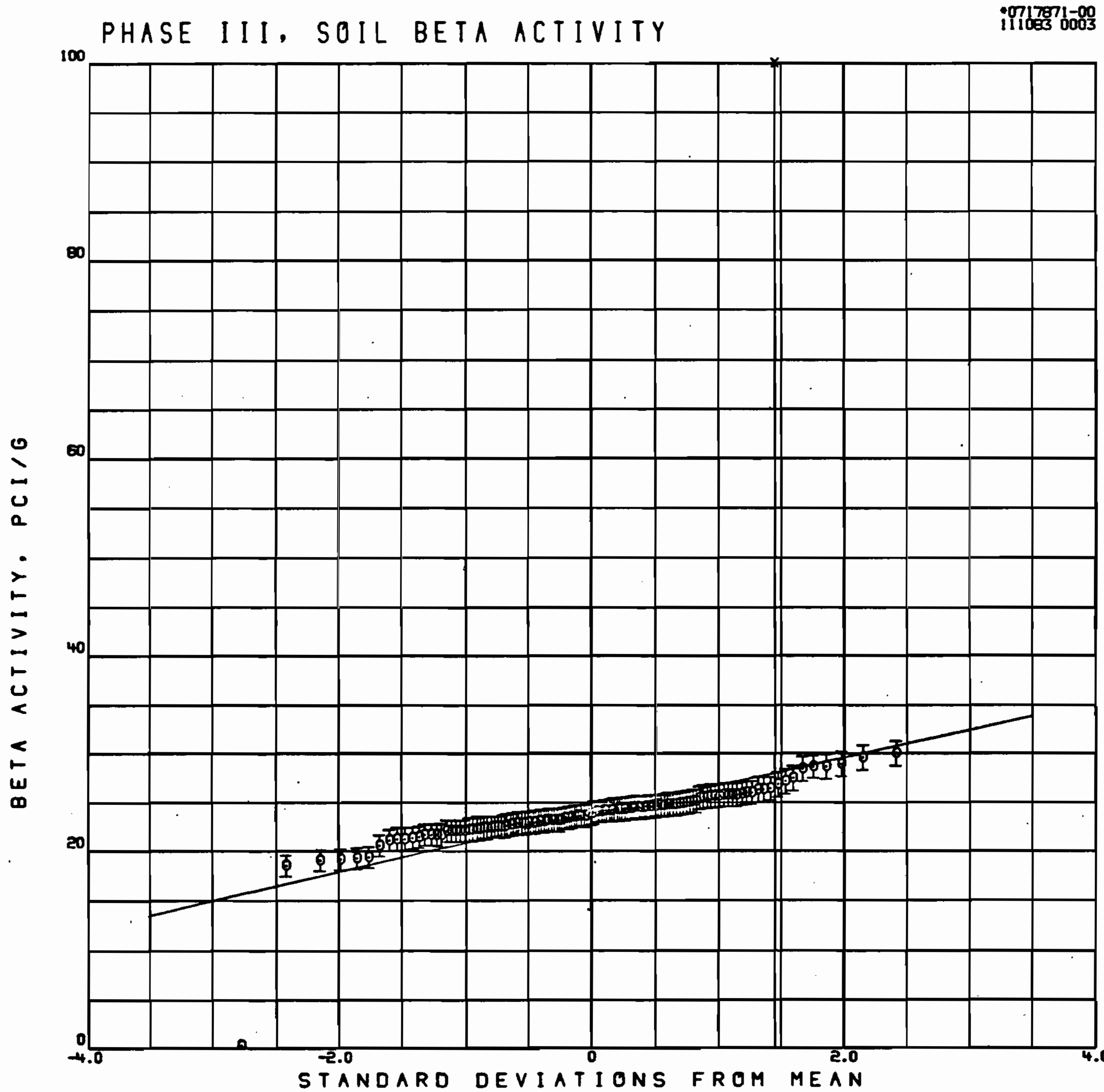

Figure 13. Cumulative Probability Plot for Beta Soil Activity in Regions IIA and III

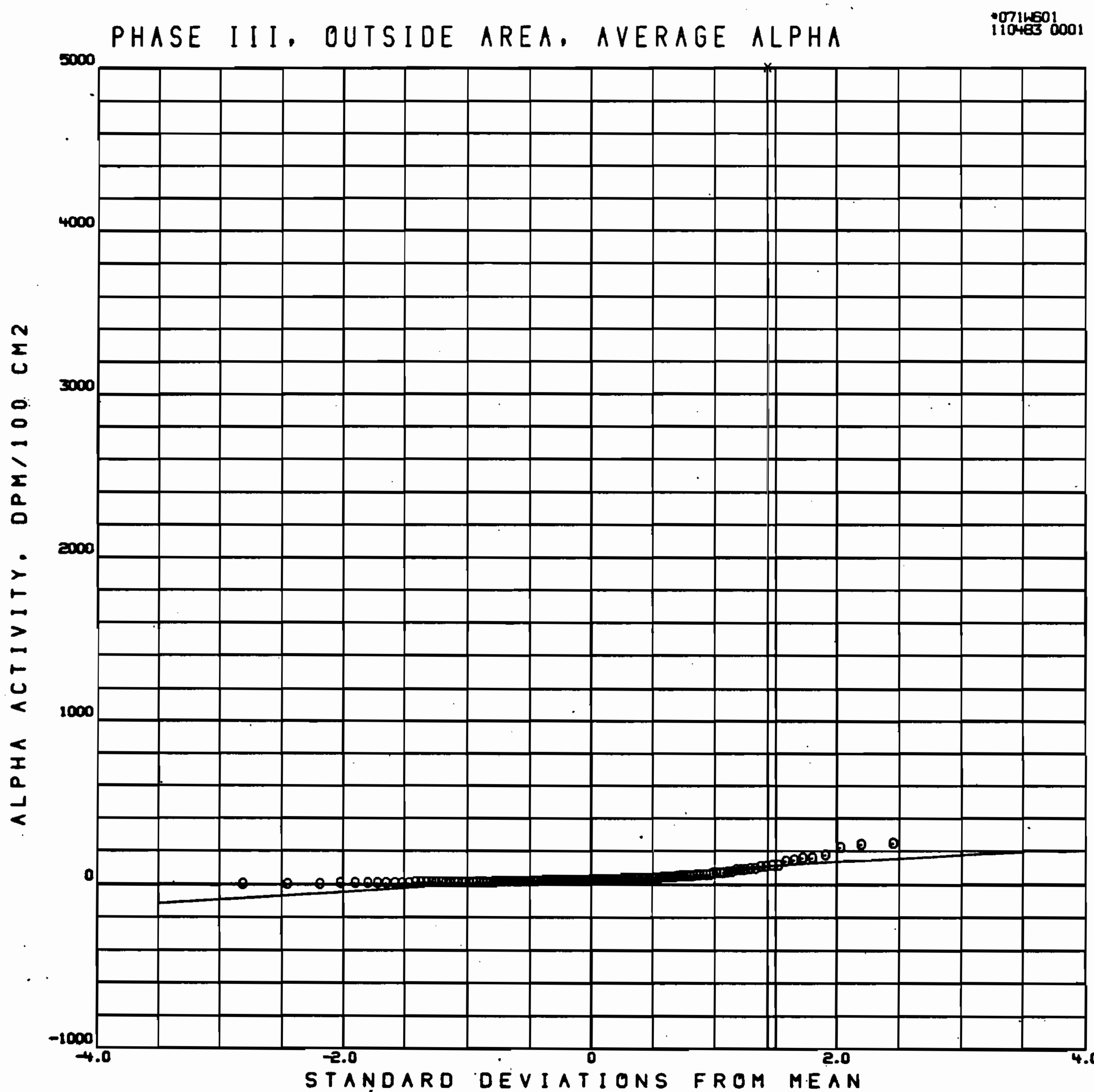

Figure 14. Cumulative Probability Plot for Average Alpha Contamination in Outside Areas

Ten "hot spots" were identified by the surveyors as having concentrated areas of alpha radioactivity. The locations and values were:

Grid	Surface Activity (dpm/100 cm^2)
F39, 4	70
F38, 1	542
F33, 1	203
F83, 6	383
F83, 8	92
F87, 8	326
F94, 5	1016
"	928
F93, 8	1462
F92, 10	389

Each spot was removed after being detected.

Figure 15. Maximum Alpha Contamination in Outside Areas

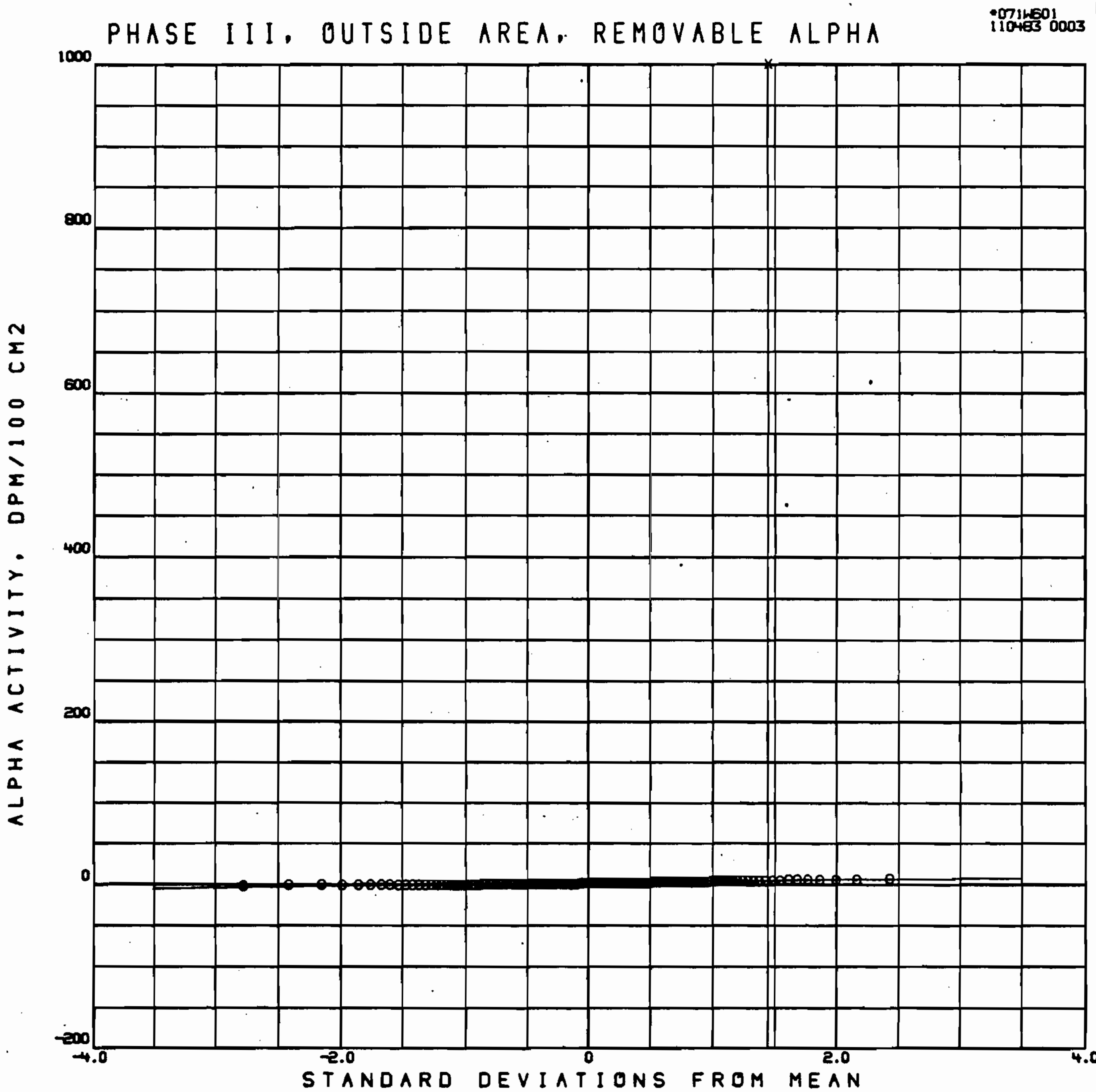

Figure 16. Cumulative Probability Plot for Removable Alpha Contamination in Outside Areas

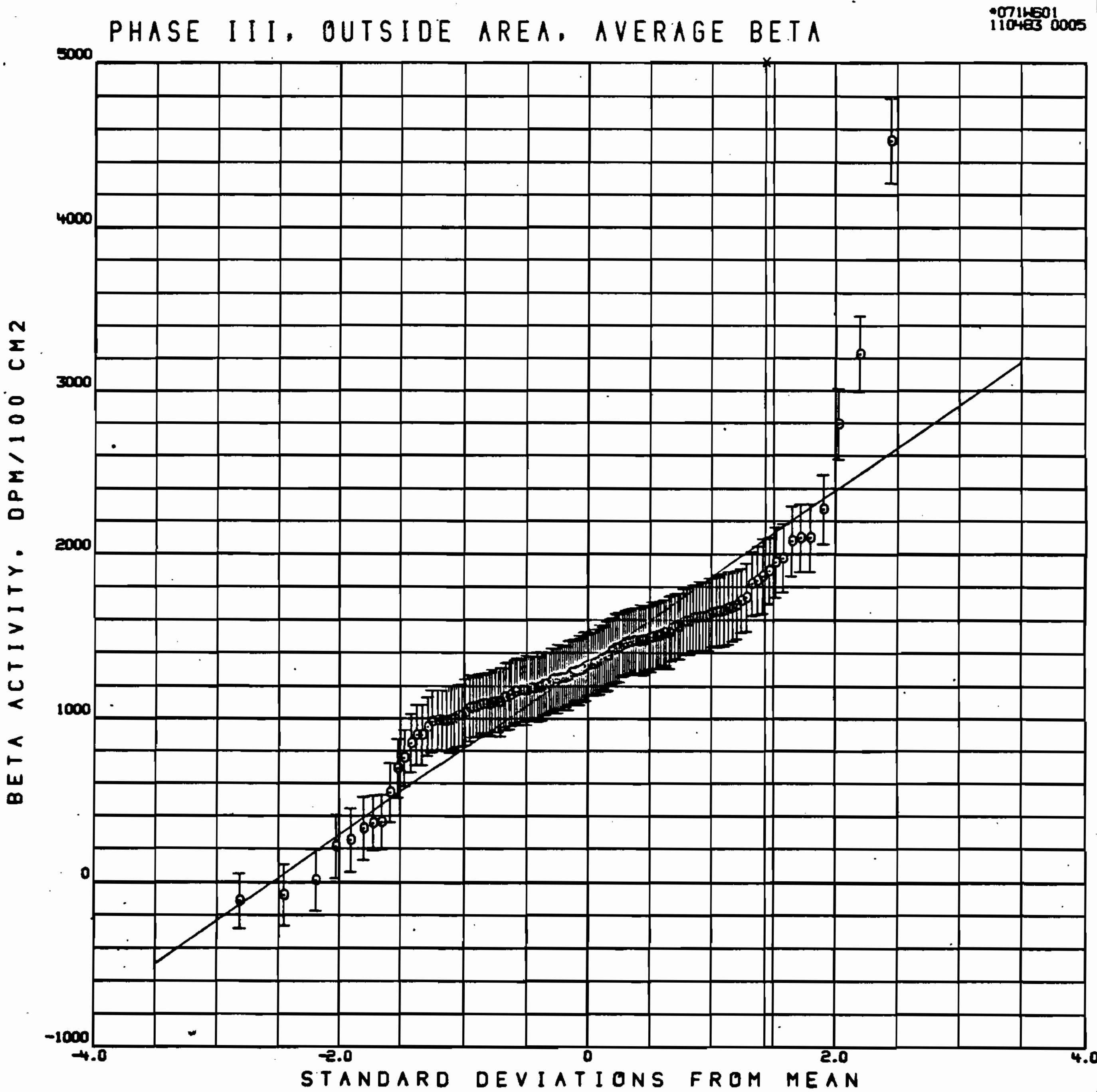

Figure 17. Cumulative Probability Plot for Average Beta Contamination in Outside Areas.

Nine "hot spots" were identified by the surveyors as having concentrated areas of beta radioactivity. The locations and values were:

Grid	Surface Activity ($dpm/100\ cm^2$)
F39, 4	11420
F38, 1	7114
F35, 3	94612
F33, 1	11501
F83, 6	2453
F83, 8	76413
F94, 5	1509
"	1894
F93, 8	1640

Each spot was removed after being detected.

Figure 18. Maximum Beta Contamination in Outside Areas

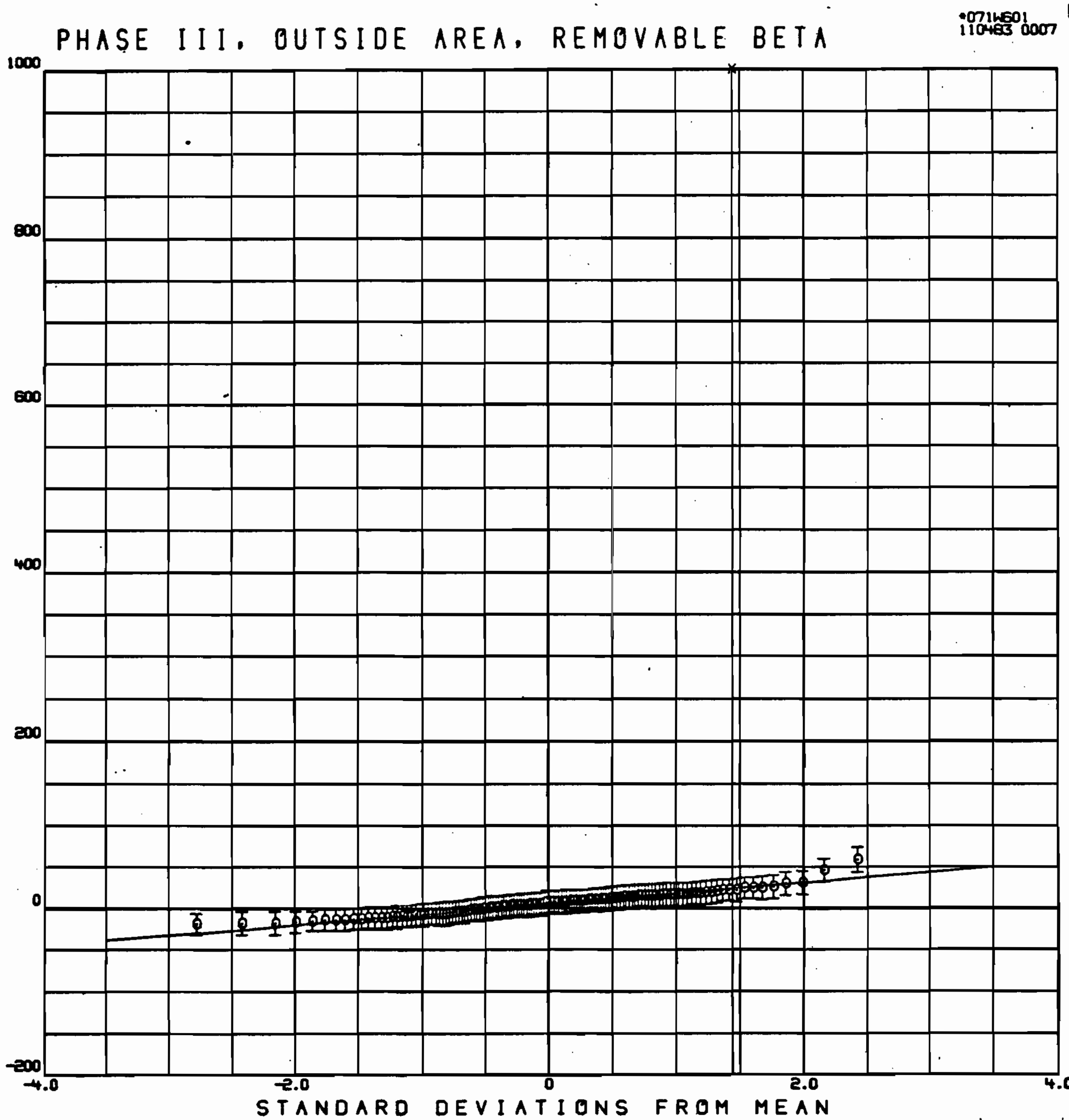

Figure 19. Cumulative Probability Plot for Removable Beta Contamination in Outside Areas

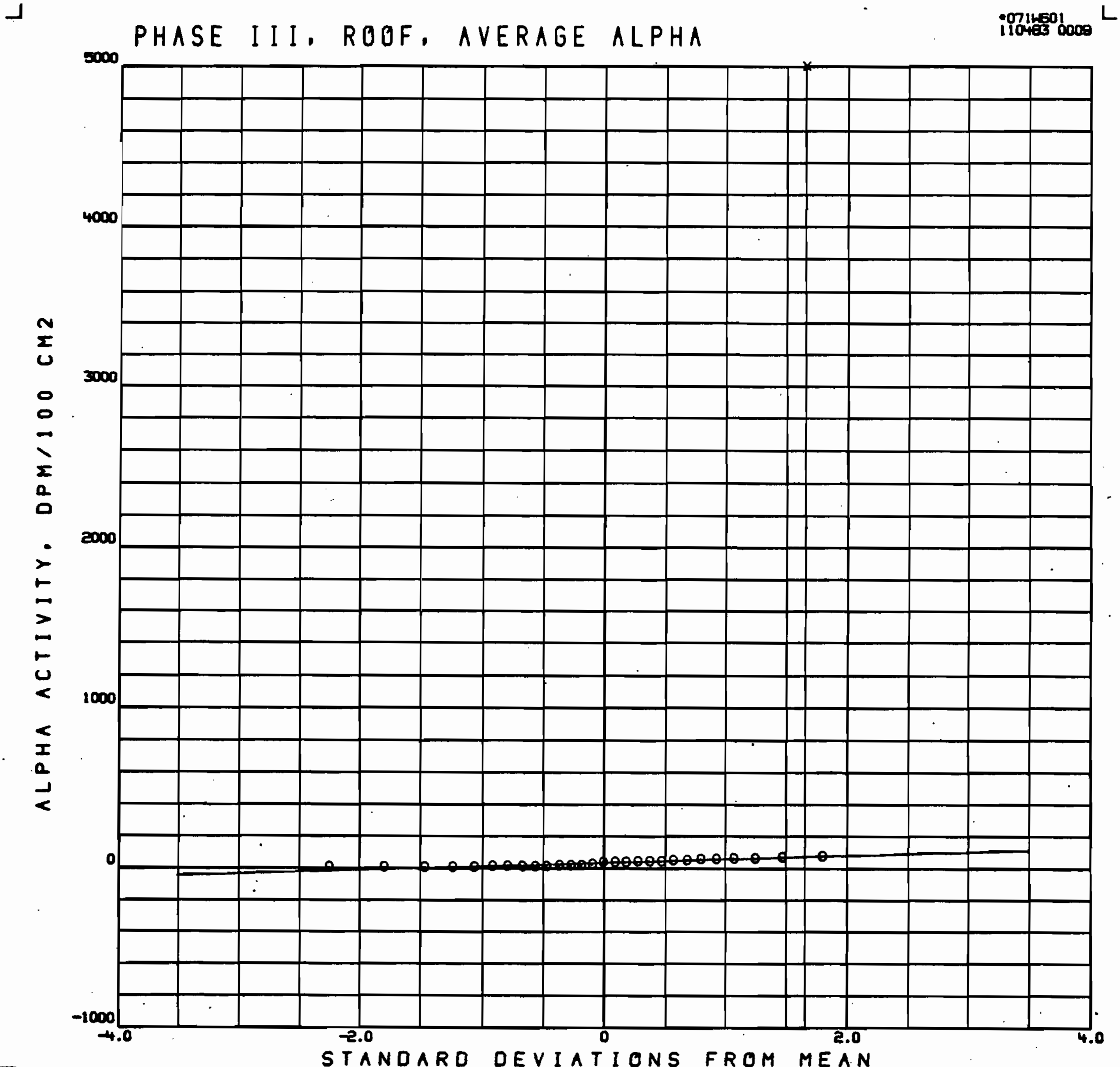

Figure 20. Cumulative Probability Plot for Average Alpha Contamination on the Roof

Four "hot spots" were found. The locations and values were:

Room	Grid	Surface Activity ($dpm/100\ cm^2$)
11B26	F5, 2	4000
11D08	F1, 5	700
11D08	F2, 9	1000
11813	F5, 1	2600

Each spot was removed after being detected.

Figure 21. Maximum Alpha Contamination on the Roof

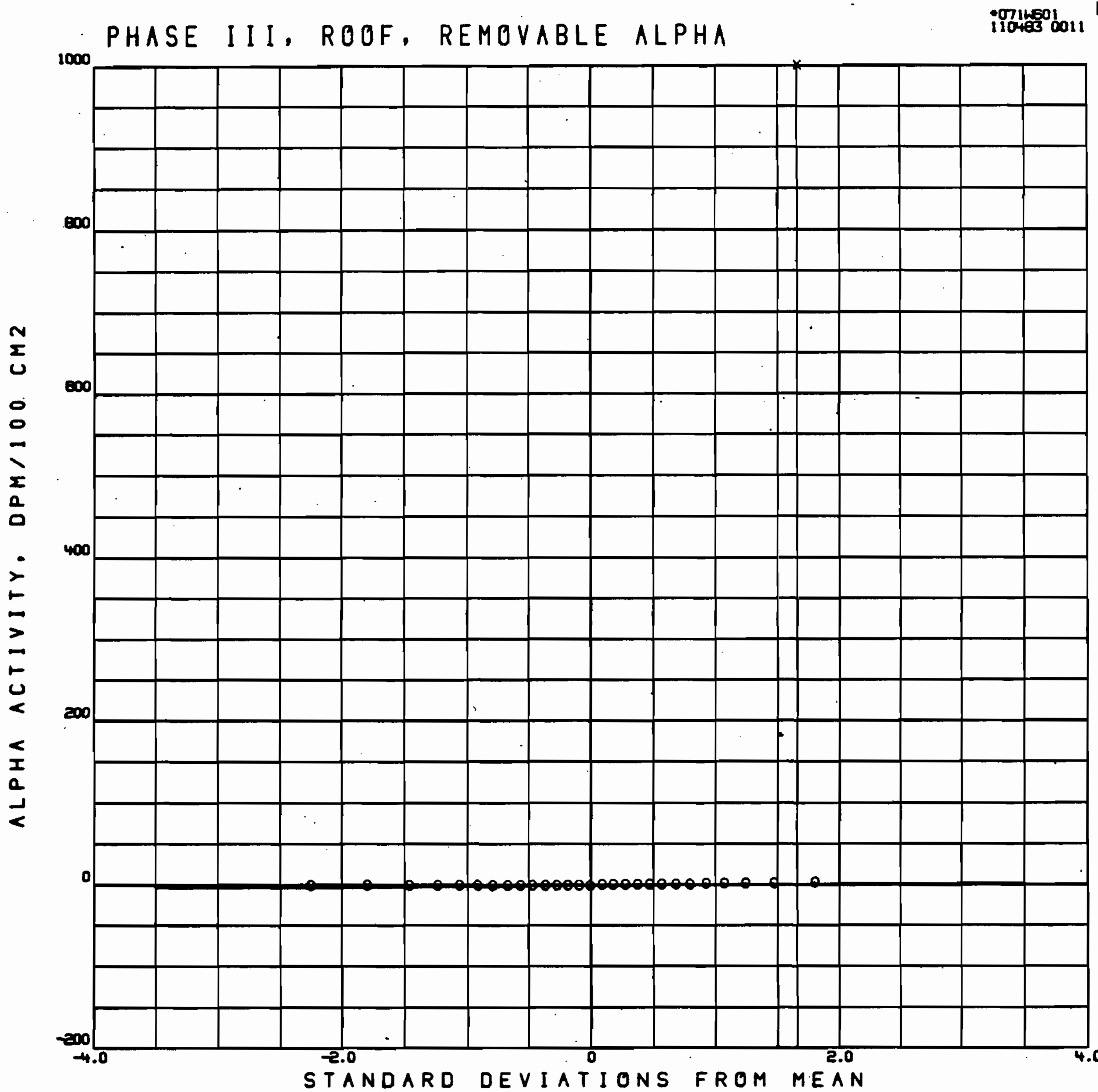

Figure 22. Cumulative Probability Plot for Removable Alpha Contamination on the Roof

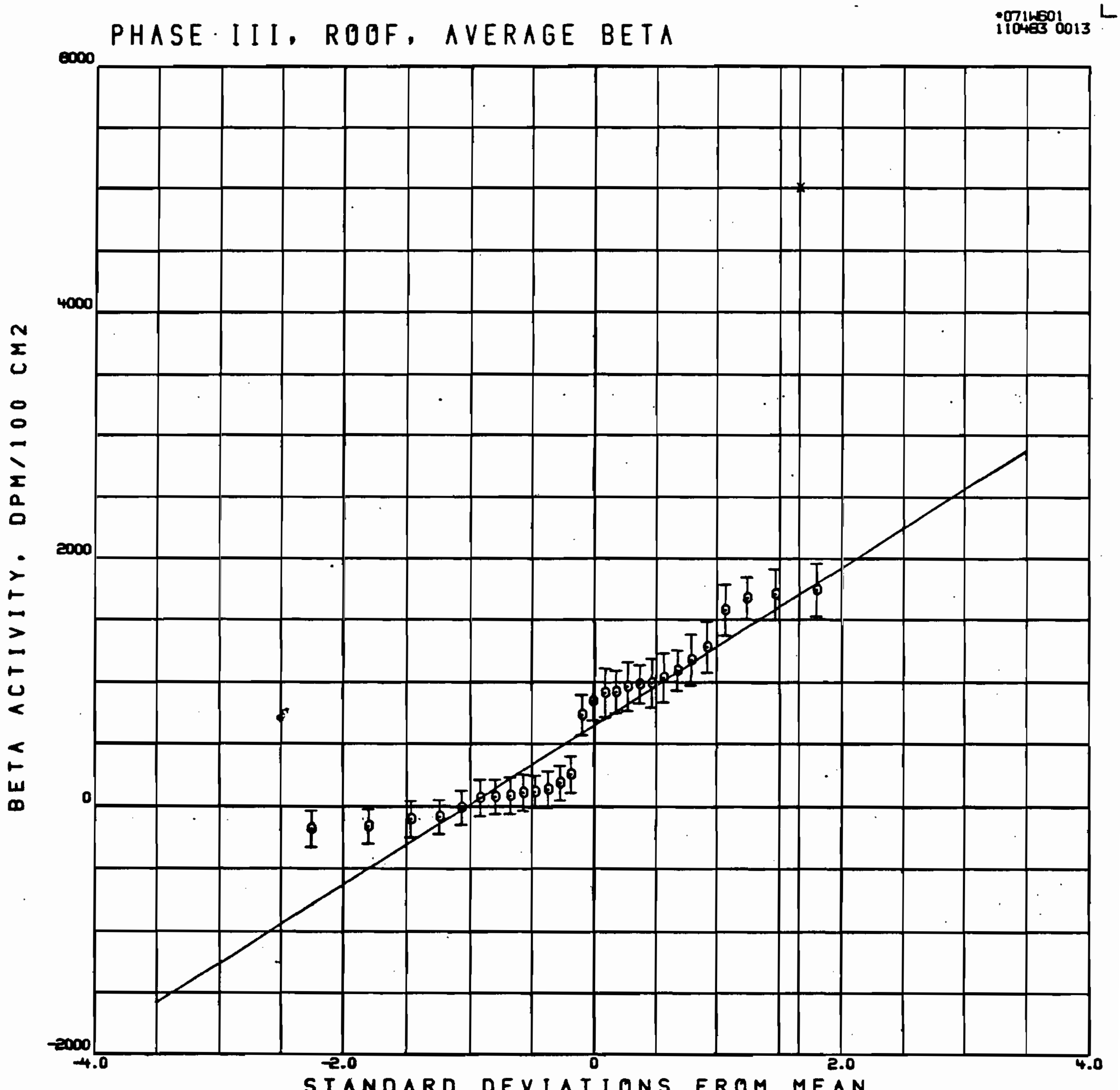

Figure 23. Cumulative Probability Plot for Average Beta Contamination on the Roof

No "hot spots" were found.

Figure 24. Maximum Beta Contamination on the Roof

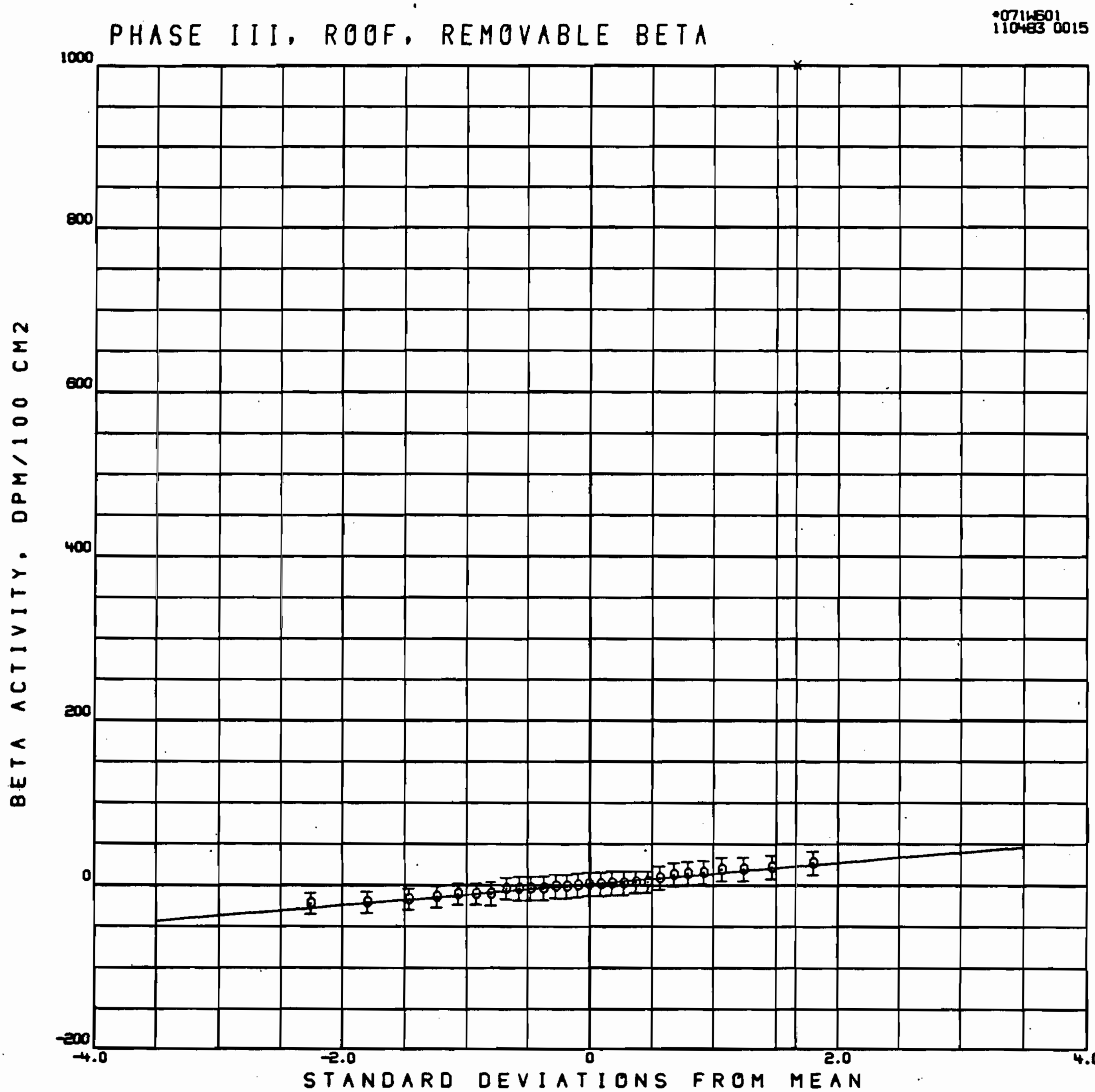

Figure 25. Cumulative Probability Plot for Removable Beta Contamination on the Roof

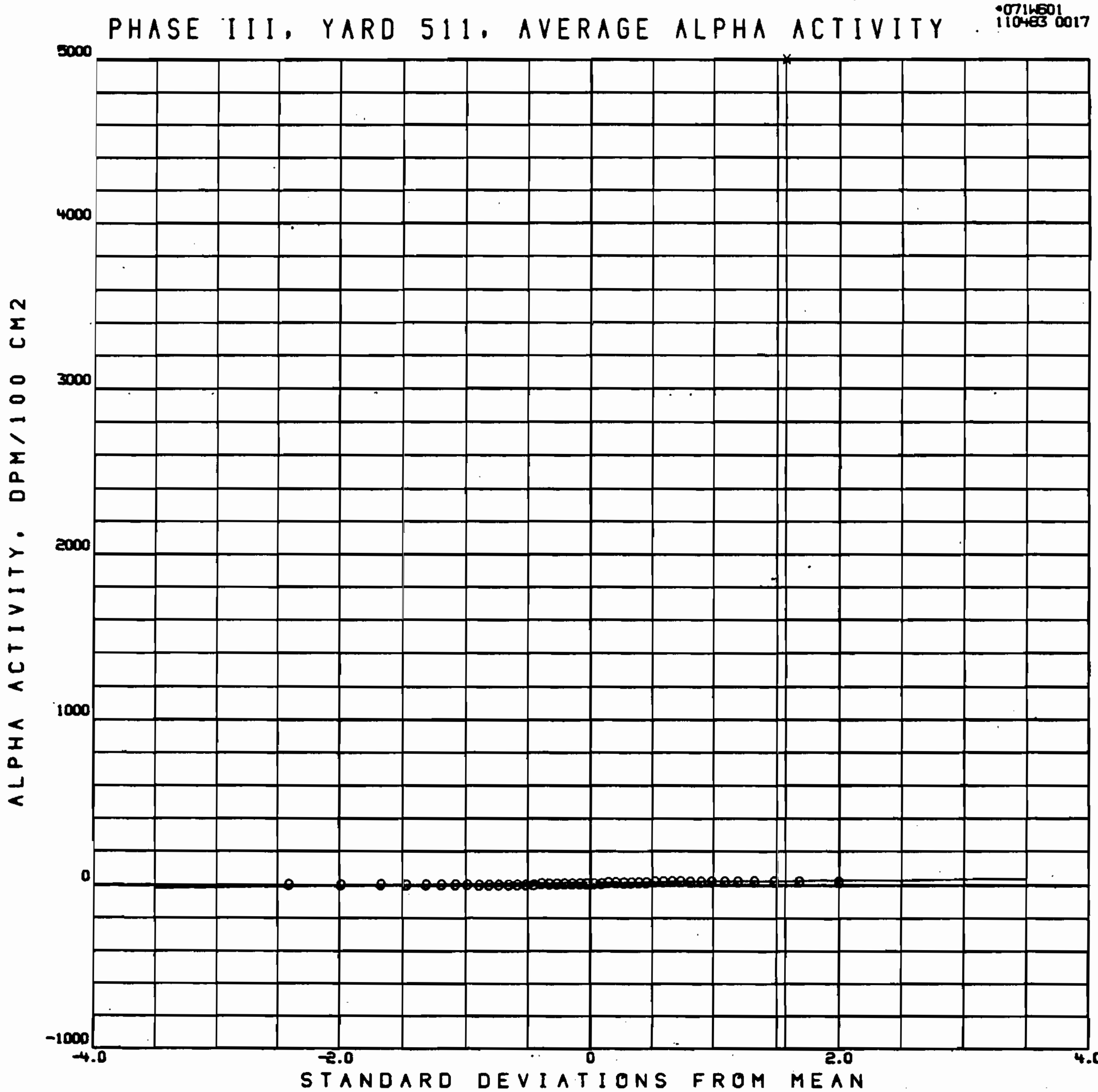

Figure 26. Cumulative Probability Plot for Average Alpha Contamination in Yard 511

No "hot spots" were found.

Figure 27. Maximum Alpha Contamination in Yard 511

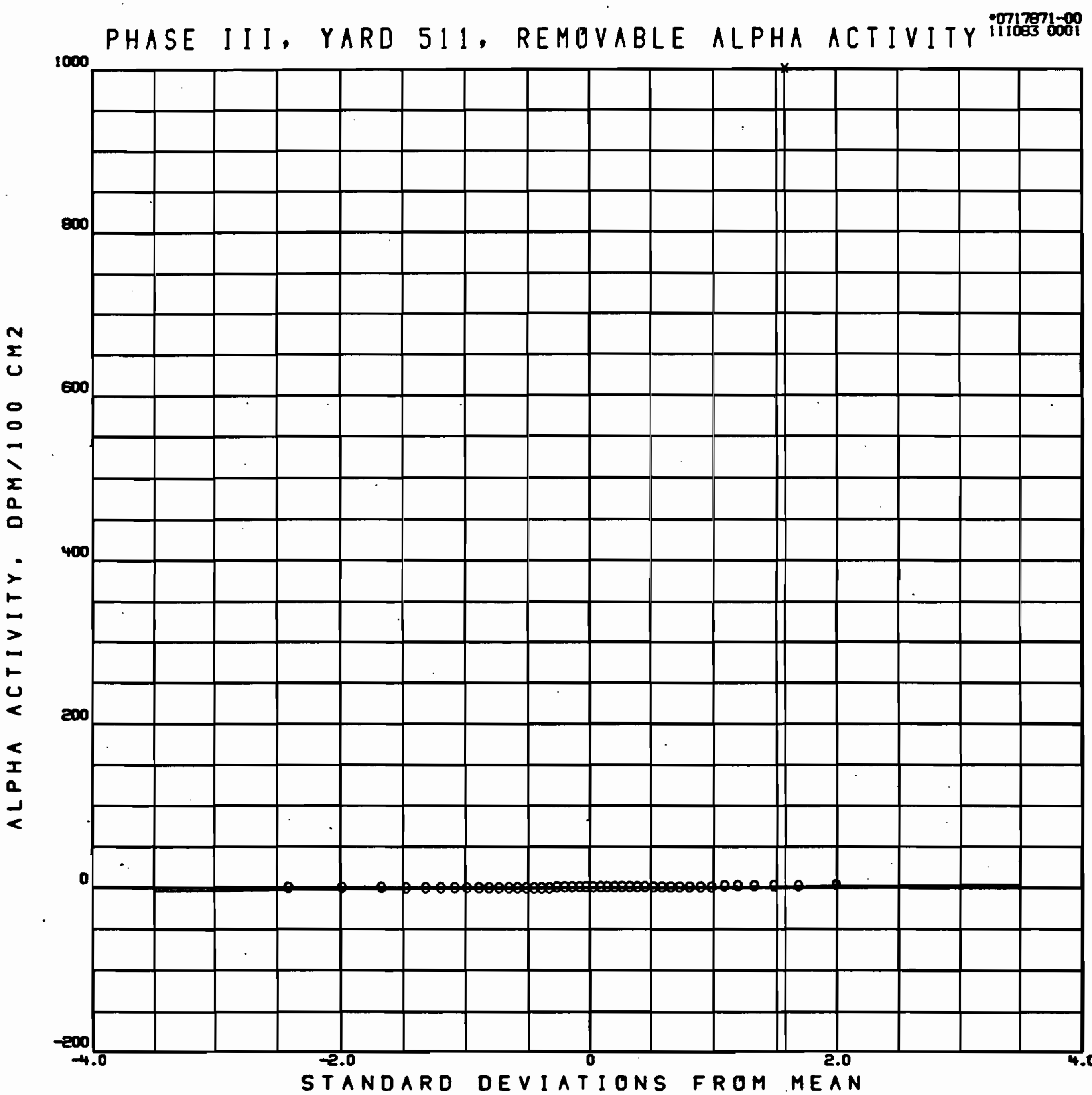

Figure 28. Cumulative Probability Plot for Removable Alpha Contamination in Yard 511

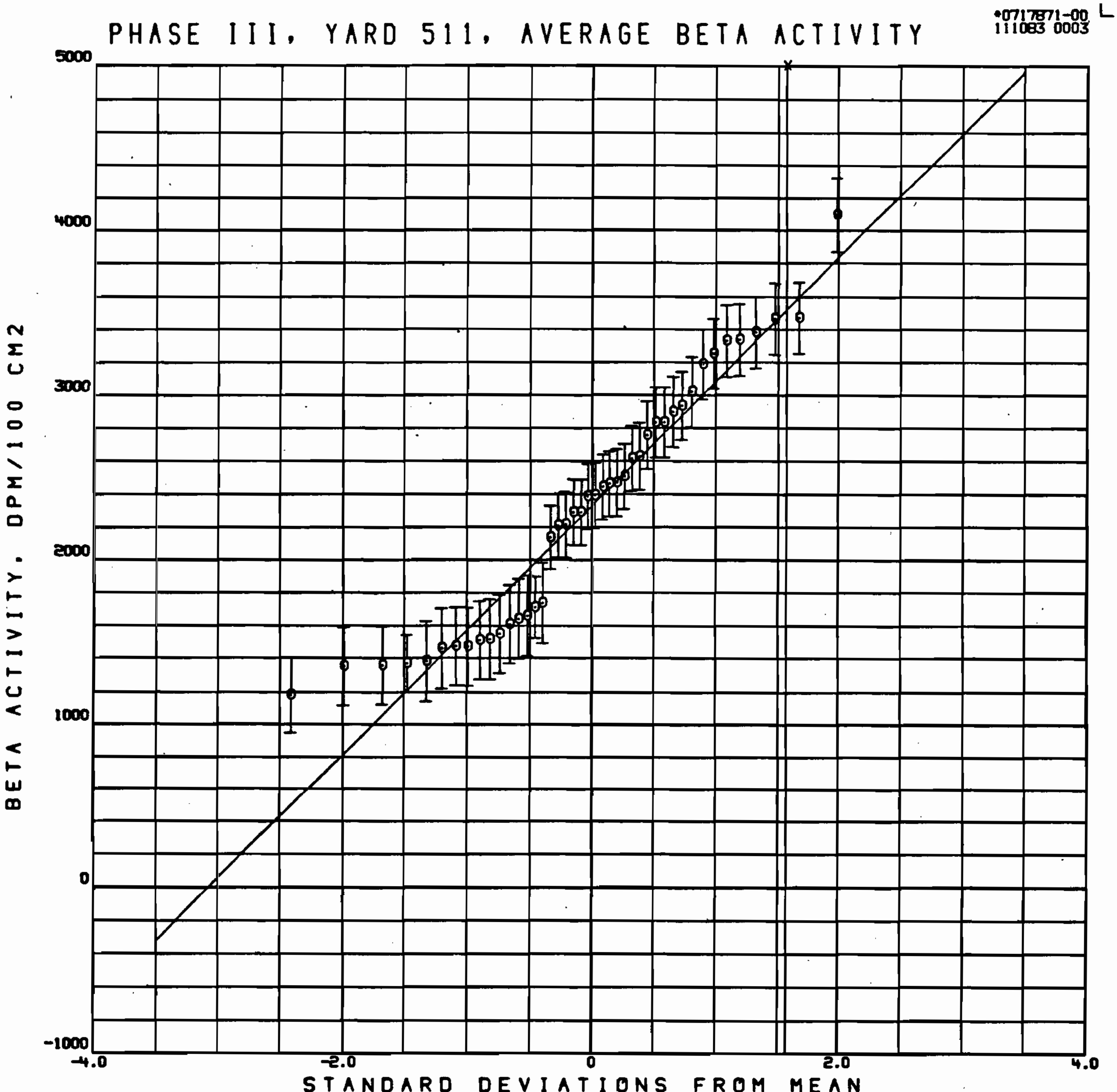

Figure 29. Cumulative Probability Plot for Average Beta Contamination in Yard 511

No "hot spots" were found.

Figure 30. Maximum Beta Contamination in Yard 511

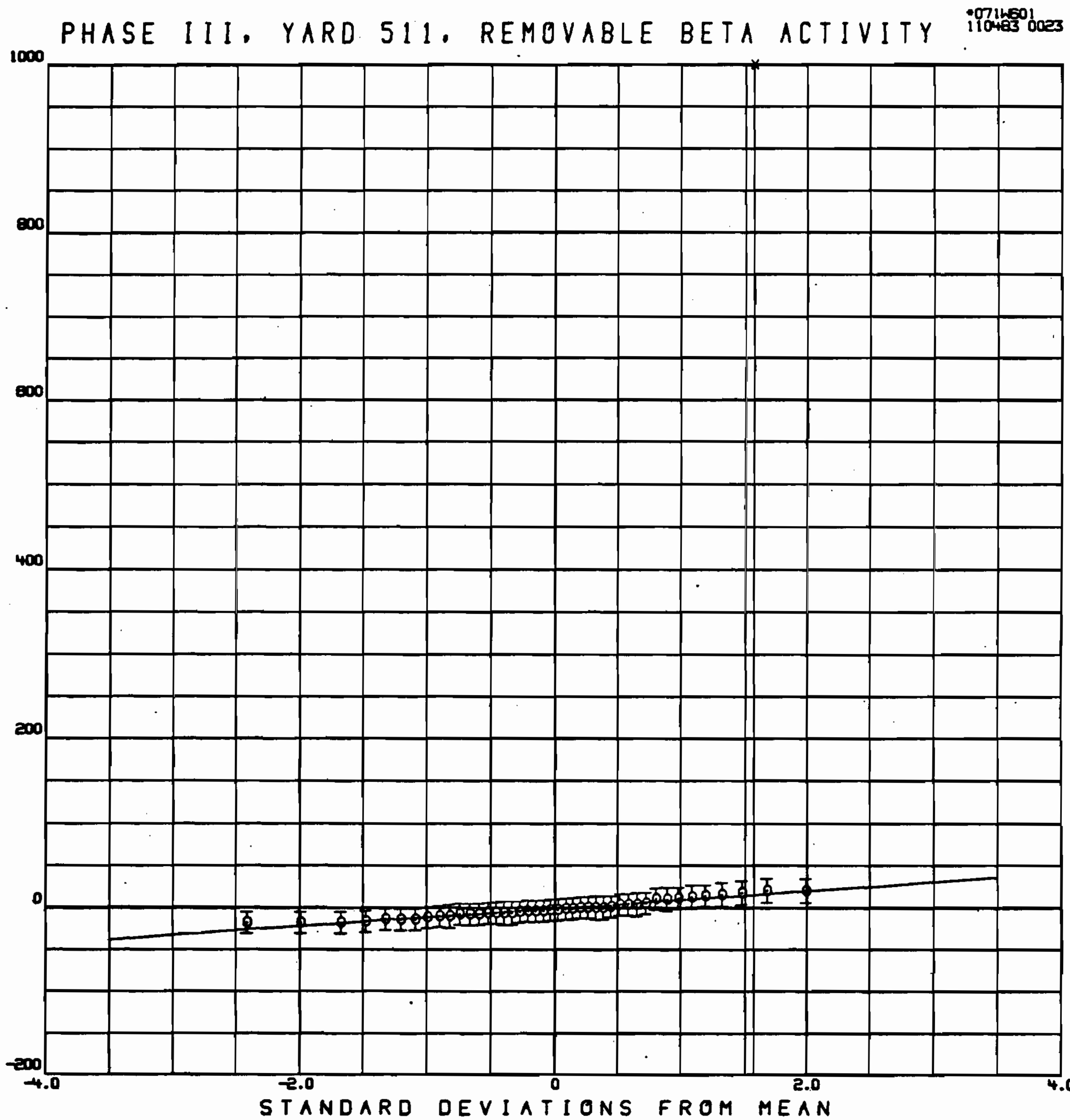

Figure 31. Cumulative Probability Plot for Removable Beta Contamination in Yard 511

VI. CONCLUSIONS

An appropriate survey has been conducted throughout the area to be released. All remaining measured values of residual radioactivity are below the acceptance limit and analysis of the data according to the sampling plan shows, in every case, the Inspection Test Statistic ($\bar{x}$ + ks) is also below the acceptance limit. This method of analysis shows that any other similar set of measurements should be found acceptable also, and further, that all locations in the regions have residual radioactivity below the limits. The results of this survey show essentially no residual contamination and demonstrate a negligible risk of there being any undetected contamination exceeding the acceptance limits. Therefore, upon concurrence by NRC, the area may be released for unrestricted use.

VII. REFERENCES

1. Special Nuclear Materials License No. SNM-21 and Technical Specification for Operations at Atomics International, AI-75-46 and License Conditions

2. "Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations," Federal Register 46, (205), 52061, October 23, 1981

3. "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use," ("DECON-1") State of California, Radiologic Health Branch, Department of Health Services (June 1977)

4. "Techniques of Statistical Analysis," C. Eisenhart, M. W. Hastay, W. A. Wallis, editors, McGraw-Hill, New York (1947)

APPENDIX A

ANNEX C TO SPECIAL NUCLEAR MATERIAL LICENSE NO. SNM-21

SEP 1 5 1977

ANNEX C

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BYPRODUCT, SOURCE, OR SPECIAL NUCLEAR MATERIAL

U. S. Nuclear Regulatory Commission
Division of Fuel Cycle and
Material Safety
Washington, D.C. 20555

NOVEMBER 1976

SEP 1 5 1977

The instructions in this guide in conjunction with Table I specify the radioactivity and radiation exposure rate limits which should be used in accomplishing the decontamination and survey of surfaces or premises and equipment prior to abandonment or release for unrestricted use. The limits in Table I do not apply to premises, equipment, or scrap containing induced radioactivity for which the radiological considerations pertinent to their use may be different. The release of such facilities or items from regulatory control will be considered on a case-by-case basis.

1. The licensee shall make a reasonable effort to eliminate residual contamination.

2. Radioactivity on equipment or surfaces shall not be covered by paint, plating, or other covering material unless contamination levels, as determined by a survey and documented, are below the limits specified in Table I prior to applying the covering. A reasonable effort must be made to minimize the contamination prior to use of any covering.

3. The radioactivity on the interior surfaces of pipes, drain lines, or ductwork shall be determined by making measurements at all traps, and other appropriate access points, provided that contamination at these locations is likely to be representative of contamination on the interior of the pipes, drain lines, or ductwork. Surfaces of premises, equipment, or scrap which are likely to be contaminated but are of such size, construction, or location as to make the surface inaccessible for purposes of measurement shall be presumed to be contaminated in excess of the limits.

4. Upon request, the Commission may authorize a licensee to relinquish possession or control of premises, equipment, or scrap having surfaces contaminated with materials in excess of the limits specified. This may include, but would not be limited to, special circumstances such as razing of buildings, transfer of premises to another organization continuing work with radioactive materials, or conversion of facilities to a long-term storage or standby status. Such requests must:

   a. Provide detailed, specific information describing the premises, equipment or scrap, radioactive contaminants, and the nature, extent, and degree of residual surface contamination.

   b. Provide a detailed health and safety analysis which reflects that the residual amounts of materials on surface areas, together with other considerations such as prospective use of the premises, equipment or scrap, are unlikely to result in an unreasonable risk to the health and safety of the public.

5. Prior to release of premises for unrestricted use, the licensee shall make a comprehensive radiation survey which establishes that contamination is within the limits specified in Table I. A copy of the survey report shall be filed with the Division of Fuel Cycle and Material Safety, USNRC, Washington, D.C. 20555, and also the Director of the Regional Office of the Office of Inspection and Enforcement, USNRC, having jurisdiction. The report should be filed at least 30 days prior to the planned date of abandonment. The survey report shall:

   a. Identify the premises.

   b. Show that reasonable effort has been made to eliminate residual contamination.

   c. Describe the scope of the survey and general procedures followed.

   d. State the findings of the survey in units specified in the instruction.

Following review of the report, the NRC will consider visiting the facilities to confirm the survey.

SEP 1 5 1977

TABLE I

ACCEPTABLE SURFACE CONTAMINATION LEVELS

NUCLIDES [a]	AVERAGE [b c f]	MAXIMUM [b d f]	REMOVABLE [b e f]
U-nat, U-235, U-238, and associated decay products	5,000 dpm α/100 cm^2	15,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except SR-90 and others noted above.	5,000 dpm $\beta\gamma$/100 cm^2	15,000 dpm $\beta\gamma$/100 cm^2	1,000 dpm $\beta\gamma$/100 cm^2

[a] Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.

[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c] Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

[d] The maximum contamination level applies to an area of not more than 100 cm^2.

SEP 1 5 1977

TABLE I
2

[e]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

[f]The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/hr at 1 cm and 1.0 mrad/hr at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.